Evaluation of anterior open-bite treatment with occlusal adjustment

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Introduction: The purpose of this study was to evaluate the cephalometric and occlusal changes, the functional occlusion, and the dentinal sensitivity of anterior open-bite treatment with occlusal adjustment. **Methods:** The sample comprised 20 patients who experienced relapse of the anterior open bite (mean, –1.06 mm). Occlusal adjustment was performed until a positive overbite was established. Cephalometric changes were evaluated on lateral cephalograms taken before and after the occlusal adjustment. The functional occlusion analysis consisted of evaluating immediate anterior and canine guidance and the number of teeth in contact before and after the procedure. Dentinal sensitivity was evaluated before, shortly after, and 4.61 months after the occlusal adjustment. Pretreatment and posttreatment cephalometric changes and the number of teeth in contact were compared with dependent *t* tests. Percentages of anterior and canine guidance before and after the adjustment procedure were compared with the McNemar test. To compare dentinal sensitivity at several stages, the nonparametric Friedman test was used, followed by the Wilcoxon test. **Results:** Significant increases in overbite and mandibular protrusion were seen, as were significant decreases in apical base discrepancy, facial convexity, and growth pattern angles. The percentages of immediate anterior and canine guidance increased significantly, as did the number of teeth with occlusal contacts. Dentinal sensitivity increased immediately after the adjustment but decreased to normal levels after 4.61 months. **Conclusions:** Occlusal adjustment is a viable treatment alternative for some open-bite patients; it establishes positive vertical overbite and improves the functional occlusion with only transient dentinal sensitivity. (Am J Orthod Dentofacial Orthop 2008;134:10.e1-10.e9)

Several protocols for correcting an anterior open bite in the permanent dentition have been investigated regarding treatment effects, indications, contraindications, and stability.[1-8] Among these protocols, some authors have advocated correcting the anterior open bite with occlusal adjustment in certain patients.[9-12] This procedure is not usual but can provide a satisfactory result in some situations.[10-12]

Ehrlich et al[12] conducted a 10-year longitudinal study of treatment modalities for overbite-overjet occlusal relationships and found that comprehensive treatment combining orthodontics, occlusal adjustment, and selective restorations minimized the need for extensive restorative dentistry. Eighteen adults with anterior open bite treated with occlusal adjustment showed great improvement of anterior and canine guidances after open-bite closure and had stable and physiologic occlusion in the follow-up observation period. The authors emphasized that, in these patients, periodic evaluations are required to monitor supportive tissue and provide minor additional occlusal adjustments.[12]

Several case reports demonstrated the efficacy of occlusal adjustment in closing an anterior open bite.[9-11] Bonfante et al[11] presented a clinical report in which the occlusal adjustment was the treatment choice of an adult with an open bite. After selective grinding, the anterior open bite was reduced, and canine guidance was achieved. After 10 months, improved occlusal stability, oral comfort, and esthetics were observed. Vatteone[10] used occlusal adjustment in severe open-bite patients, in whom only molars had occlusal contact.

Questions that arise about this protocol concern the amount of tooth structure that can be removed without compromising dentinal sensitivity and the proportional amount of open bite than can be corrected. Until now, no controlled investigation of this procedure has been conducted. This study was undertaken to evaluate the cephalometric and occlusal changes of anterior open-bite treatment with occlusal adjustment, the improvement in functional occlusion, and the consequent dentinal sensitivity.

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Table I. Definitions of the cephalometric variables and abbreviations used

P-NB	Distance from pogonion to N-B line
P-Nperp	Distance from pogonion to a perpendicular line to Frankfort plane (Po-Or) through point N
SNB	Angle between lines S-N and N-B
Wits	Distance between perpendicular projections of Points A and B on the functional occlusal plane
ANB	Angle between lines N-A and N-B
NAP	Angle between lines N-A and A-P
FMA	Frankfort mandibular plane angle: angle between lines Po-Or and Go-Me
SN.GoGn	Angle between lines S-N and Go-Gn
NSGn	Angle between lines N-S and S-Gn
Total posterior face height (S-Go)	Distance between points S and Go
Posterior molar height (PMH)	Distance from palatal plane to Go-Me, in a line drawn parallel to LAFH, passing through the middle of the crown of the maxillary second molar
Lower anterior face height (LAFH)	Distance between anterior nasal spine (ANS) and menton (Me)
S-Go/LAFH	Proportion of S-Go and LAFH.
Overjet	Distance between incisal edges of maxillary and mandibular central incisors, parallel to Frankfort plane
Overbite	Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to occlusal plane
Md1-AP	Distance from most anterior point of the crown of mandibular central incisor to A-P line
Md1.NB	Angle between mandibular central incisor long axis and N-B line
Md1-NB	Distance from most anterior point of the crown of mandibular central incisor to N-B line
Soft-tissue convexity (Gl′Sn′Pog′)	Angle formed between lines through soft-tissue glabela (Gl′), subnasale (Sn′), and soft-tissue pognonion (Pog′)
Interlabial gap	Distance between the most inferior point of the upper lip and the most superior point of the lower lip
Lower lip to E plane (LL-E)	Distance between the most anterior point of lower lip and Ricketts' E-plane

MATERIAL AND METHODS

The sample consisted of 20 patients (8 men, 12 women) with a mean age of 21.81 years (SD, 4.06; range, 17.58-31.50 years) obtained from the files of the Department of Orthodontics, Bauru Dental School, University of São Paulo, Bauru, São Paulo, Brazil. All patients originally had an anterior open-bite malocclusion, had undergone orthodontic treatment with fixed appliances, and had an anterior open-bite relapse after a mean period of 4.15 years (range, 1-6 years) posttreatment. Relapse of anterior open bite was defined as a negative overbite between the maxillary and mandibular incisors in the follow-up observation period. These patients had a mean overbite of –1.06 mm (range, –0.20 to –3.60 mm). The transversal and sagittal relationships of these patients' occlusions were suitable for occlusal adjustment to obtain favorable anterior and canine guidances during excursive movements, according to the guidelines of the procedure.[13,14] Only slight crowding relapse was tolerated in the maxillary and mandibular dental arches. Tongue thrust was not evaluated, but myofunctional therapy had been recommended to all patients after orthodontic treatment.

This study was approved by the Ethics in Research Committee of the University of São Paulo, and all subjects signed informed consent.

Lateral cephalograms were evaluated to determine vertical dentoalveolar and skeletal changes with the occlusal adjustment. The cephalometric tracings and landmark identifications were made on acetate paper by 1 investigator (M.V.C.) and then digitized with a Numonics Accugrid XNT digitizer (Houston Instruments, Austin, Tex). These data were stored in a computer and analyzed with Dentofacial Planner (version 7.02, Dentofacial Planner Software, Toronto, Ontario, Canada); it corrected the image magnification factors of the lateral cephalograms of 6% and 9.8%.

All cephalometric measurements are described in Table I, and the less usual cephalometric structures, lines, planes, and measurements are illustrated in Figure 1.

The occlusal adjustment procedure was performed in centric relation (CR), according to the method of Okeson.[15] The patient reclined in the dental chair. CR (condyles seated in superoanterior position in the fossae) was bimanually located.[16] The teeth were lightly brought together, and the patient identified the tooth that was felt to contact first. The mouth was then opened, and the teeth were thoroughly dried with an air syringe or cotton roll. Articulating paper held with forceps was placed on the side identified as having the first contact. The mandible was again guided to CR, and the teeth touched lightly by tapping on the paper. The

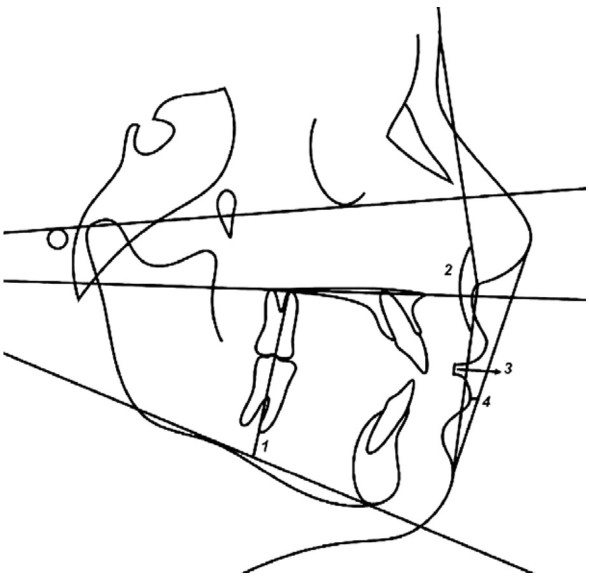

Fig 1. Less usual cephalometric variables: *1,* PMH; *2,* soft-tissue convexity (Gl′Sn′Pog′); *3,* interlabial gap; *4,* lower lip to E-plane.

contact areas were located for the maxillary and mandibular teeth. One contact, or both contacts, will be on an incline—either the mesial and distal incline or the buccal and lingual incline. To eliminate the CR slide, these inclines must be reshaped into cusp tips or flat surfaces.[15] Contacts between cusp tips and flat surfaces direct the occlusal forces through the long axes of the teeth. When initial premature contacts were eliminated, more teeth had contacts and then could be adjusted by the same technique, until all posterior teeth had simultaneous contacts, and until the open bite was closed when possible, according to patient sensitivity (Figs 2 and 3). Then the lateral and protrusive excursions were adjusted.[15] No repositioning splint was used to obtain CR because the patients were asymptomatic.[15]

An inverted-cone diamond slow-speed bur (#38, KG Sorensen, São Paulo, Brazil) was used for grinding. After the adjustment, the ground area was polished by the pumice method. Fluoride solution was applied to the ground tooth surface for 5 minutes.[17] Daily mouthwash with 0.05% sodium fluoride solution was prescribed for 6 months. Two to 4 appointments were necessary to close the bite in these patients. In 7 patients, the open bite was closed in 2 appointments; 3 appointments were needed for 8 patients, and only 5 patients needed 4 appointments to close the open bite. The number of appointments depended on the severity of the negative overbite. The greater the open bite, the more appointments. The mean interval between appointments was 21 days, and dentinal sensitivity contributed to increasing the time between appointments. No other orthodontic procedure was undertaken.

Immediate anterior guidance during protrusive mandibular excursion and canine guidance during lateral mandibular excursions were clinically evaluated before and after the procedure. Ideally, there should be 12.7 μm of clearance between the maxillary and the mandibular anterior teeth in centric occlusion (CO) or CR.[18,19] If the maxillary and mandibular anterior teeth or canines were farther apart than this distance and would not disclude the posterior teeth during protrusion or lateral mandibular excursions, a lack of anterior or canine guidance was considered to exist.

The number of teeth with occlusal contacts was evaluated with articulating paper before and after occlusal adjustment.[20,21] Contacts in the embrasure were counted as 2 teeth.

Dentinal sensitivity was evaluated before the adjustment, after 1.35 months (SD, 0.45; range, 0.43-2.30 months), and after 4.61 months (SD, 0.60; range, 2.63-5.20 months) with the sensitivity test of Price et al.[22] This test consists of a questionnaire applied in the referred stages to evaluate dentinal sensitivity of the equilibrated teeth. The level of sensitivity was evaluated in relation to mastication, heat, cold, citrus fruits, and percussion.[23] The patient answered each question on a visual analog scale (VAS) (0 to 10; 0 = no pain, and 10 = the worst pain imaginable).[22]

A month after the first measurements, 15 randomly selected cephalograms were retraced and remeasured by the same examiner (M.V.C.). The casual error was calculated according to Dahlberg's formula[24] ($Se^2 = \Sigma d^2/2n$), where Se^2 is the error variance and d is the difference between the 2 determinations of the same variable. The systematic errors were evaluated with dependent *t* tests at $P < 0.05$.[25] Examiner agreement in the numbers of teeth in contact from the measurements 2 weeks apart was tested with intraclass coefficients generated by the kappa statistic.[26]

Statistical analyses

To compare the pretreatment and posttreatment cephalometric changes and the numbers of teeth in contact, dependent *t* tests were used. To evaluate the percentages of anterior and canine guidances before and after the adjustment procedure, the nonparametric McNemar test was used. To compare the dentinal sensitivity at the several stages, the nonparametric Friedman and the Wilcoxon tests were used. The level of significance was 5%. These analyses were performed with Statistica software (Statistica for Windows, version 6.0, Statsoft, Tulsa, Okla).

Fig 2. Intraoral photographs before occlusal adjustment show the anterior open bite.

Fig 3. Intraoral photographs after occlusal adjustment show the corrected anterior open bite.

RESULTS

Casual and systematic errors are listed in Table II. Only the variables SN.GoGn and Gl′Sn′Pog′ had systematic errors; casual errors varied from 0° (S-Go/LAFH) to 1.22° (Md1.NB). Table III shows excellent intraexaminer agreement. The coefficients showed an almost perfect agreement rate.

Overbite increased significantly with treatment and caused significant changes in other skeletal and soft-tissue variables. There was a significant increase in mandibular protrusion (P-Nperp); this reduced the maxillomandibular anteroposterior discrepancy (ANB) and facial convexity (NAP). The facial pattern variables (FMA, SN.GoGn, NSGn) and the vertical linear variables (PMH, LAFH, and S-Go/LAFH) had significant reductions. The soft-tissue profile also had reductions in facial convexity and in the amount of interlabial gap (Gl′Sn′Pog′, interlabial gap) (Table IV). The mean changes in the variables and their standard deviations are also shown in Tables IV and V (absolute values).

There were significant increases in the percentages of anterior and canine guidances, as well as in the number of teeth with occlusal contacts (Tables VI and VII).

Dentinal sensitivity increased significantly during mastication, and with heat and percussion stimuli, after the occlusal adjustment and decreased to the initial condition after 4.61 months (Table VIII).

DISCUSSION

Selection of this sample was difficult because the open-bite subjects had to have satisfactory dental relationships except for a mild anterior open bite to undergo this treatment procedure. Finding original anterior open-bite malocclusions that satisfied these criteria was impossible in a limited time because its prevalence is low.[27] Therefore, we decided to select treated patients whose open bite had relapsed and who were willing to retreat their malocclusion. Two choices of retreatment were presented to the patients: retreatment with complete fixed appliances and vertical intermaxillary elastics or occlusal adjustment. Those who chose treatment with occlusal adjustment participated ($n = 20$). Although this size might not be statistically ideal, it can be considered satisfactory, considering the rigid selection criteria. The difficulty in selecting this type of sample is also illustrated in the literature, with several reports of only1 patient.[9-11]

Several methods can measure dentinal sensitivity.[22,23,28] We used the VAS of Price et al[22] to evaluate sensitivity with mastication, heat, cold, citrus fruits, and percussion, as has also been used by others.[23,28] The VAS questions are simple, and most patients can easily answer them.

Cephalometric changes

Because the primary focus of this study was the overbite, the discussion will initially concentrate on its

Table II. Casual and systematic errors between the first and second measurements (n = 15)

Variable	Measurement 1 Mean	Measurement 1 SD	Measurement 2 Mean	Measurement 2 SD	Dahlberg	P
Mandibular components						
P-NB	1.20	1.29	1.18	1.36	0.29	0.8584
P-Nperp	–5.90	7.83	–5.92	7.65	0.79	0.9302
SNB	78.22	3.90	78.18	3.88	0.23	0.7111
Maxillomandibular relationship						
Wits	–0.38	2.44	–0.32	2.25	0.45	0.7299
ANB	4.62	2.92	4.80	3.01	0.36	0.2061
NAP	8.040	6.65	8.28	6.82	0.55	0.2366
Facial pattern						
FMA	31.40	9.11	31.02	8.97	0.70	0.1534
SN.GoGn	37.64	10.15	37.06	9.97	0.63	0.0072*
NSGn	70.40	5.10	70.30	4.85	0.37	0.5144
Vertical components						
S-Go	75.13	8.20	75.02	8.08	0.41	0.4935
PMH	54.95	4.23	54.76	4.20	0.49	0.3152
LAFH	73.63	5.00	73.29	4.98	0.52	0.0777
S-Go/LAFH	1.02	0.16	1.03	0.15	0.00	0.3667
Dentoalveolar components						
Overjet	2.98	0.75	3.17	0.70	0.32	0.1141
Overbite	0.24	1.42	0.59	1.14	0.50	0.3440
Md1-AP	4.38	1.54	4.30	1.63	0.23	0.3636
Md1.NB	31.63	5.76	31.06	5.69	1.22	0.2156
Md1-NB	7.61	2.53	7.57	2.50	0.29	0.7243
Soft-tissue components						
Gl′Sn′Pog′	165.34	7.64	164.71	7.62	0.73	0.0123*
Interlabial gap	2.23	3.37	2.09	3.34	0.36	0.3129
LL-E	0.30	2.51	0.10	2.41	0.30	0.0624

*Statistically significant at $P < 0.05$.

Table III. Intraexaminer error investigation (kappa statistics)

	Percentage of agreement (%)	Coefficient value	Strength of agreement
Number of teeth with occlusal contacts	90.00	0.86	Almost perfect

changes and later on the consequences of these changes on the several dentoskeletal and soft-tissue components.

There was a mean increase in overbite of 2.38 mm, correcting the open bite of –1.06 to 1.32 mm on average; this can be regarded as clinically significant because correction of the open bite was the primary patient concern (Table IV). This result confirmed previous case reports demonstrating the efficacy of the procedure to close an open bite.[9-12] Additionally, with the cephalometric evaluation in these patients, it was possible to indirectly quantify the enamel amount ground from the posterior teeth, especially the second molars, which are the teeth with greater amounts of enamel ground, by the changes in posterior molar height (PMH). The PMH decreased by 1.29 mm, on average after the occlusal adjustment, so it can be estimated that this is the amount of enamel removed from the occlusal surfaces of the maxillary and mandibular second molars. Dividing this amount between both molars means that each second molar was ground by 0.645 mm. Since the enamel thickness on the occlusal surface of the second molars is on average 2 mm,[29] a good amount of healthy enamel was left on these teeth. In addition, the amount of enamel that can be ground or stripped corresponds to half of the available enamel on each surface,[30] and also the amount of enamel that can be removed without damaging the patient is extremely variable, depending on each tooth shape.[17,31,32] Therefore, if the teeth that were mostly ground had enamel amounts within the safety limits, it is expected that the other teeth were also ground well within these limits.

It has been reported that an anterior overbite increase of 3 mm is consequent to 1 mm of enamel removed from the occlusal surface of the posterior teeth, establishing a 3/1 rate.[16,33] However, in these studies it was not specified which posterior teeth were

Table IV. Means and standards deviations of cephalometric variables before and after occlusal adjustment (OA), changes between times of evaluation (n = 20), and results of dependent *t* tests

	Before OA		*After OA*			*Changes (after-before)*	
Variable	*Mean*	*SD*	*Mean*	*SD*	*P*	*Mean*	*SD*
Mandibular components							
P-NB	1.35	1.69	1.78	1.81	0.0049*	0.42	0.59
P-Nperp	–8.65	9.17	–7.47	9.31	0.0105*	1.17	1.85
SNB	78.16	4.50	78.44	4.34	0.0982	0.28	0.72
Maxillomandibular relationship							
Wits	–0.37	2.12	–0.34	2.51	0.9082	0.03	1.34
ANB	4.47	2.36	3.95	2.26	0.0035*	–0.52	0.69
NAP	7.45	5.62	6.13	5.32	0.0007*	–1.32	1.48
Facial pattern							
FMA	32.20	7.72	31.27	7.45	0.0009*	–0.93	1.06
SN.GoGn	37.09	8.20	36.20	8.06	0.0017*	–0.89	1.09
NSGn	70.38	4.70	69.67	4.67	0.0010*	–0.71	0.82
Vertical components							
S-Go	75.40	6.58	75.24	6.71	0.6391	–0.16	1.50
PMH	54.72	4.25	53.43	4.12	0.0000*	–1.29	0.60
LAFH	73.95	5.41	71.82	4.76	0.0000*	–2.13	0.94
S-Go/LAFH	1.02	0.12	1.05	0.12	0.0000*	0.02	0.01
Dentoalveolar components							
Overjet	2.82	1.23	2.68	0.76	0.3958	–0.14	0.72
Overbite	–1.06	0.81	1.32	0.91	0.0000*	2.38	0.91
Md1-AP	4.84	2.03	4.82	2.06	0.8939	–0.01	0.49
Md1.NB	32.36	6.38	31.54	6.23	0.0704	–0.81	1.90
Md1-NB	7.96	2.27	7.88	2.38	0.4063	–0.08	0.42
Soft-tissue components							
Gl′Sn′Pog′	163.48	6.55	164.75	6.54	0.0007*	–1.27	1.42
Interlabial gap	2.72	3.04	1.14	1.92	0.0181*	–1.58	2.74
LL-E	0.52	2.20	0.01	2.26	0.0544	–0.51	1.12

*Statistically significant at $P < 0.05$.

Table V. Means, minimums, maximums, and standard deviations of the treatment changes in LAFH, PMH, overbite, and the proportions between these variables

	Mean	*Minimum*	*Maximum*	*SD*
LAFH change	2.13	0.70	4.40	0.94
PMH change	1.29	0.45	2.71	0.60
Overbite change	2.38	1.10	4.00	0.91
LAFH change/PMH change	1.83/1	1.00/1	4.44/1	0.87/1
Overbite change/PMH change	2.13/1	1.15/1	4.88/1	1.11/1

Table VI. Comparison of the frequency of immediate anterior and canine guidances during functional excursions (protrusion, and right and left lateral excursions) before and after occlusal adjustment (OA) (McNemar test)

Functional excursion	*Before OA*	*After OA*	*P*
Right excursion	25%	90%	0.0009*
Left excursion	20%	95%	0.0003*
Protrusion	0%	70%	0.0005*

*Statistically significant at $P < 0.05$.

taken as the measuring parameters. On the other hand, Woelfel[34] found a 1.5/1 ratio when measuring at the level of the first molars. Our results show that the overbite change/PMH change corresponded to 2.38/1.29, resulting in a 2.13/1 rate, which is smaller than previously reported[16,35] (Table V). This difference might have been because of including extraction patients in the sample; extractions position the second molars more mesially in the closing arc, and less grinding is necessary. This is important information for clinicians when considering correcting an anterior open bite with occlusal adjustment, because the amount of enamel to be ground on the posterior teeth corresponds to approximately half of the amount of the open bite to be corrected, according to these results. This result can be criticized because the initial open bite was evaluated in CO, and, at posttreatment, it was evaluated in CR.

Table VII. Comparison of total number of teeth with occlusal contacts before and after occlusal adjustment (OA) (dependent *t* test)

	Before OA		*After OA*		
	Mean	*SD*	*Mean*	*SD*	*P*
Number of teeth with occlusal contacts	13.80	3.53	16.25	2.33	0.0000*

*Statistically significant at $P < 0.05$.

Table VIII. Comparison of dentinal sensitivity to several factors, before, shortly after, and 4.61 months after occlusal adjustment (OA) (Friedman and Wilcoxon tests)

Factor	*Before OA*	*1.35 months after OA*	*4.61 months after OA*	*P*
Mastication	0^{A}	3.37^{B}	0.55^{A}	0.0000*
Heat	0^{A}	1.70^{B}	0.10^{A}	0.0017*
Cold	0^{A}	0.75^{A}	0.15^{A}	0.0757
Citrus fruits	0^{A}	0.32^{A}	0.00^{A}	0.3877
Percussion	0^{A}	0.19^{B}	0.01^{A}	0.0062*

Different letters represent statistically significant differences.
*Statistically significant at $P < 0.05$.

Patients who initially have a deviation between CO and CR can have a greater open bite in CR. Nevertheless, the PMH would also be larger. Therefore, in spite of criticism, this method provides a good estimate of the proportional amount of tooth structure to be ground. Also, when calculating the amount of open bite to be corrected, one should add at least a sufficient amount to establish a positive overbite, providing immediate anterior and canine guidances.

The standard deviation for the proportion of overbite change to PMH change should also be considered because variations from 1.02/1 to 3.24/1 (mean ± 1 SD) are possible (Table V). Probably, most of this wide variation is attributable to the specific characteristics of our subjects. The sample included nonextraction, 2 maxillary premolar, and 4 premolar extraction patients. These different protocols placed the second molars more mesially or distally, contributing to the wide variation of these variables.

It is important to notice the cephalometric changes after this small vertical change from the occlusal adjustment. There were a statistically significant mandibular projection (P-Nperp), an improvement in the maxillomandibular relationship (ANB), and a decrease in facial convexity (NAP) (Table IV). The facial pattern angles had a statistically significant decrease, as well as the vertical components. The relationship between change in lower anterior facial height and posterior molar height was 2.13/1.29, resulting in a 1.83/1 rate (Table V). These dentoskeletal changes also produced favorable changes in the soft tissues, decreasing facial convexity (Gl'Sn'Pog') and the interlabial gap (Table IV). This benefits facial esthetics because these patients usually have a vertical craniofacial pattern, frequently with a convex profile and no passive lip seal. It is not surprising to obtain these cephalometric changes with changes in vertical dimensions, but they were not expected to be so statistically evident in patients having occlusal adjustments.[1,36,37] However, although statistically significant, it is questionable whether they can be considered clinically significant. This must be further investigated. Because open-bite patients usually have predominant vertical growth, these changes certainly are not detrimental.

It is difficult to compare these results with previous studies because no systematic investigation has been concerned with occlusal adjustment as a treatment for anterior open bite. Several case reports demonstrated the efficacy of the procedure in correcting anterior open bite; these support our results.[9-12] Despite these, in most other reports, the occlusal adjustment was used to improve interdigitation of the teeth after orthodontic treatment, refine the interocclusal relations, and distribute the masticatory forces among all posterior teeth.[13,14,20,38-42]

Functional occlusion changes

Because the whole sample had anterior open bite at the initial stage, the immediate anterior guidance was not detected in protrusion. Even with this occlusal deficiency, 25% and 20% of the patients had canine guidance for the right and left functional excursions, respectively (Table VI). This demonstrates that the open bites were not severe; otherwise, they could not have had this procedure because of the great amount of occlusal grinding that would be necessary.

After occlusal adjustment, the results showed 90 and 95% of canine guidance for the right and left lateral excursions, respectively, and 70% of immediate anterior guidance in protrusion (Table VI). Immediate anterior and canine guidances could not be obtained in some patients because of their dentinal sensitivity. This is the main factor that restricts open-bite correction with this procedure.

We tried to obtain canine guidance in the lateral functional excursions, but, when the canines were unfavorably positioned, a group function was tolerated.[43] Similarly, when immediate anterior guidance was not possible at the beginning of protrusion, disclusion was established on the premolars until the incisors reached contact.[12]

After occlusal adjustment, the number of teeth with contact points increased significantly, from 13.80 in CO to 16.25 in CR; this improved masticatory efficiency and patient comfort.[16,38] (Table VII)

Dentinal sensitivity was the primary concern in treating open bites with occlusal adjustment because caries susceptibility is not a concern in adults, who are most likely to have this procedure.[9-12,17] The results demonstrated significant increases in dentinal sensitivity after 1.35 months of the occlusal adjustment for mastication, heat, and percussion (Table VIII). However, 4.61 months after the procedure, sensitivity had returned to initial levels. This recovery might have been aided by the prophylactic procedures after tooth grinding.[17,32] Therefore, although some patients experience transient discomfort after the occlusal adjustment to close the open bite, the cost-benefit ratio might justify the procedure because of the improvement for the patient.[44]

Clinical considerations

The indication for this procedure to treat open-bite patients is restricted. Perhaps it should be the treatment choice for relapse of treated open-bite patients, if there are satisfactory anteroposterior and transverse relationships, as in our subjects, because untreated open-bite patients who could satisfy these criteria can be difficult to find. Additionally, the other characteristics of a potential patient must be similar to those of treated patients—mean open bite of –1.06 mm (range, –0.20 to –3.60 mm) and mean age of 21.81 years (range, 17.58-31.50 years)—to have similar results. Applying this treatment procedure in younger patients is not advisable because they usually have a greater dentinal sensitivity,[45] with remaining growth that could be unfavorable and contribute to the relapse. On the other hand, application in older patients would not cause similar concerns. Enamel thickness must also to be considered when thinking of this procedure. Usually, the cost-benefit ratio would be favorable because the average molar enamel wear during lifetime (70 years) is 2.03 mm.[46] Therefore, in most adults, it can be undertaken, because there would still be enough enamel to undergo physiologic enamel wear. Special consideration is needed if the patient has a bruxing habit, because tooth wear is greater in these patients. This procedure could be considered an adjunct to treatment of open-bite patients in the permanent dentition who have a high rate of relapse.[6,8,47-49] Occlusal adjustment in relapsed patients would help in decreasing the rate of relapse. The advantages of this approach are that only a few sessions are necessary, with statistically and clinically significant changes in overbite in a short time. Overbite changes can be considered clinically significant, since a negative overbite was corrected to a positive overbite. However, the other statistically significant changes we observed should be studied for their clinical significance, even though they were not detrimental.

It is also speculated that treatment stability will be greater because the teeth do not undergo unstable movements.[50] These patients differ from growing patients, who can have open-bite relapse because of greater dentoalveolar vertical development of the posterior teeth or less vertical dentoalveolar development of the maxillary incisors.[48,51] The only major factor that could cause relapse would be abnormal muscle function, especially tongue thrust, in these adults who had no tooth extrusion or intrusion.[52] This is usually a factor in open-bite relapse, but it has not been thoroughly and systematically investigated because of inherent difficulties in evaluating muscle function as a significant causative agent.[52] Therefore, the stability of this procedure needs to be studied. These patients will be followed, and their stability investigated and reported. Nevertheless, this study at least has set some parameters for the procedure regarding the amount of ground enamel and the dentinal sensitivity to it. Although dentinal sensitivity increased immediately after the procedure, it subsided 4 months later.

CONCLUSIONS

Occlusal adjustment as an approach to treat open-bite malocclusion in certain patients produced the following changes: a 2.38-mm increase in overbite, a 1.29-mm enamel reduction of the second molars, an increase in contact points in CR, a significant increase in the number of patients with immediate anterior and canine guidances, and a significant increase in dentinal sensitivity immediately after the procedure that subsided after 4.61 months.

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