

Anchorage Loss—A Multifactorial Response

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Abstract: Anchorage loss (AL) is a potential side effect of orthodontic mechanotherapy. In the present study, it is defined as the amount of mesial movement of the upper first permanent molar during premolar extraction space closure. In addition, AL is described as a multifactorial response in relation to the extraction site, appliance type, age, crowding, and overjet. For this study, 87 university clinic and private practice subjects, who were defined as maximum anchorage cases and had undergone bilateral maxillary premolar extractions, were divided into four groups according to extraction site (first vs second premolars), mechanics (lingual vs labial edgewise appliances), and age (adolescents vs adults). Overjet and crowding were examined from the overall sample. Data were collected from serial lateral cephalograms and dental casts. The results showed that as the severity of dental crowding increased, AL significantly decreased ($r = -0.66, P = .001$). Labial edgewise appliances demonstrated a significantly greater AL than did lingual edgewise appliances (1.15 ± 2.06 mm, $P < .05$). A greater, though not statistically significant, AL was found in adults than in adolescents (0.73 ± 1.43 mm). There was a slight nonsignificant increase in AL between maxillary second compared with first premolar extractions (0.51 ± 1.33 mm). Overjet was weakly correlated to AL. These results suggest that AL is a multifactorial response and that the five examined factors can be divided into primary (crowding, mechanics) and secondary factors (age, extraction site, overjet), in declining order of importance. (*Angle Orthod* 2003;73:730–737.)

Key Words: Anchorage; Lingual orthodontics; Age; Extraction

INTRODUCTION

Anchorage is the resistance to unwanted tooth movement^{1,2} and is commonly described as the desired reaction of posterior teeth to space closure mechanotherapy to achieve treatment goals, ie, minimum, medium, maximum anchorage.³ Anchorage loss (AL) is a reciprocal reaction that could obstruct the success of orthodontic treatment by complicating the anteroposterior correction of the malocclusion and possibly detracting from facial esthetics. A major concern when correcting severe crowding, excessive overjet, and bimaxillary protrusion is control of AL. There-

fore, adjunct appliances, such as the Nance holding arch, transpalatal bar, and extraoral traction, are often used to augment molar anchorage. The use of multiple teeth at the anchorage segment to form a large counterbalancing unit and the application of differential moments have also been described as methods to stabilize molar position.³⁻⁵

Factors such as malocclusion, type and extent of tooth movement (bodily/tipping), root angulation and length, missing teeth, intraoral/extraoral mechanics, patient compliance, crowding, overjet, extraction site, alveolar bone contour, interarch interdigitation, skeletal pattern, third molars, and pathology (ie, ankylosis, periodontitis) affect AL. Most of the AL studies focus on biomechanical solutions.⁴⁻¹⁰ For example, a greater AL was demonstrated with nonsliding mechanics when the Gjessing spring was evaluated.⁶ Tip-edge brackets showed less but not significant AL than straight wire brackets (1.71 vs 2.33 mm).⁷ Differential moments have been reported to reduce AL by 0.6 – 0.7 mm.^{4,5} When maximum anchorage is required, AL was greater in Class I (0.60 mm) than in Class II (0.28 mm) malocclusions.⁴

AL has also been referred to as the extent of incisor protraction (1.8 – 2 mm) following molar distalization with repelling magnets or nickel titanium open coil springs^{8,9} supported by a Nance appliance or the second premolar (1.6 mm). However, minimal incisor anchorage loss (0.92) has

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Accepted: February 2003. Submitted: October 2002.

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been reported when the pendulum appliance was used.¹⁰ Molar AL had occurred supported with an implant in the center of the anterior palate (0.7–1.1 mm), but this was probably caused by deformation of the transpalatal bars that linked the implant to the maxillary molars.¹¹

The concept of a well-interdigitated occlusion acting to enhance molar anchorage is an accepted dogma. Therefore, it could be hypothesized that the posterior disocclusion caused by the anterior bite plane effect of a lingual appliance might negate this. Thus, the decision to extract is more frequent when lingual brackets are applied in the maxillary arch.¹² Lingual archwires are more rigid because of the smaller interbracket distance.¹³

Extraction site is another factor that affects AL. Studies conducted on the effect of the Begg appliance show that the maxillary molar occupies 33.5% of the extraction site with first premolar extractions and 50.4% with first molar extractions.¹⁴ Creekmore¹⁵ found that the posterior teeth occupy one-third to one-half of the extraction space in first and second premolar extractions, respectively. Furthermore, in another study,¹⁶ no significant difference in AL was found between first or second maxillary premolar extractions (4.3 vs 4.5 mm). However, when maxillary first premolars were extracted in conjunction with mandibular first or second premolars, AL of the maxillary molars was greater when the mandibular second premolars were extracted (3.7 vs 4.7 mm).¹⁶

Dental crowding and its relationship to AL provide the first sign that it is a multifactorial response. Second premolar extraction, rather than first, is carried out far more often in cases with less crowding. This choice has been related to greater molar mesial movement.¹⁷ Additionally, the maxillary chordal arch length (distance from mesial contact point of the first molar to the contact point of the central incisors) was reported to decrease in extraction cases by 11.3 mm according to Ong and Woods¹⁶ and by 8.3 mm as reported by Luppanapornlar and Johnston.¹⁸ This difference corresponds to greater crowding found in the latter (5.8 mm) than in the former study (3.5 mm).

The effect of patient age on AL has not been widely reported. Growing patients (12.5 years) experience 2.52 mm of AL, whereas nongrowing patients (27.6 years) show an anchorage gain of 0.20 mm. The molar relationship is corrected by mandibular growth in the adolescent group (70%) and by maintaining maxillary molar position in the adult group.¹⁹

It would appear that AL is seemingly dependent on more than one factor, which, up to now, has been investigated separately. The objectives of this study were to examine the contribution of five such factors: extraction site (first vs second premolars), mechanics (lingual vs labial technique), age (growing vs nongrowing patients), crowding, and overjet and to determine their relative contributions to AL (primary vs secondary AL factors).

MATERIALS AND METHODS

The files of 211 subjects treated in the Tel Aviv University's clinic and private practices were examined for adequacy of diagnostic records. From these, a study sample consisting of 87 Class I and Class II subjects was found. Subjects were treated with either lingual ($n = 25$) or labial edgewise appliances ($n = 62$). All lingually treated subjects were nongrowing, whereas 20 of the labially treated subjects were nongrowing as determined by chronological age and normal growth curves. All subjects had undergone orthodontic treatment, which included extraction of two maxillary first or second premolars. If only maxillary premolars were extracted, treatment goals included Class I canine relationship and Class II molar occlusion. Seven subjects from the lingual group also had mandibular second premolars extracted, making their treatment goals include both a Class I canine and molar relationship.

All subjects were defined as maximum anchorage cases, requiring minimal or no anterior movement of the molars during space closure. Patients were included if the sum of their maxillary dental crowding plus double the amount of overjet together was greater than or equal to 11 mm

$$[\text{crowding} + (2 \times \text{overjet}) > 11 \text{ mm}],$$

ie, overjet varied from two to 13 mm and crowding varied from one to 10 mm.

The sample was divided into four groups.

- G1—Nongrowing subjects treated with maxillary first premolar extractions and lingual appliances ($n = 12$, age 24.8 ± 5.57 years).
- G2—Nongrowing subjects treated with maxillary second premolar extractions and lingual appliances ($n = 13$, age 24.4 ± 5.99 years).
- G3—Nongrowing subjects treated with maxillary first premolar extractions and labial appliances ($n = 20$, age 20.09 ± 5.43 years).
- G4—Growing subjects treated with maxillary first premolar extractions and labial appliances ($n = 42$, mean age 12.6 ± 1.99 years).

Comparisons were made such that when one factor (extraction site, mechanics, or age) was examined using a paired group comparison, the other two factors were non-variable. Crowding and overjet were evaluated from the paired-groups and the overall sample.

The labial subjects were treated with 0.022×0.028 -inch preadjusted brackets (Victory System, 3M Unitek, Monrovia, CA), according to a standardized maximum anchorage control regimen. The regimen included space closure by individual (sliding) canine retraction followed by en masse incisor retraction carried out on a 0.017×0.025 -inch stainless steel archwire containing Bull-loops activated one mm every four weeks and producing an initial force of 150 g per side. Archwires were preactivated with tip-back bends

immediately distal to the premolar bracket. All subjects treated with labial appliances were instructed to wear a cervical headgear, containing an elevated long outer bow, 12 hours daily. For the remainder of the day, subjects were instructed to wear Class II elastics (3/16-inch medium delivering 70–100 g).²⁰ Compliance was verified by clinical observation of molar position.

All lingual subjects were treated with bidimensional²¹ orthodontics using preadjusted brackets with a 0.018×0.025 -inch archwire slot from canine-to-canine and an 0.022×0.028 -inch slot in the posterior dentition (Ormco Corp, Glendora, CA). These brackets were oriented and bonded using a lingual jig method.²² Treatment was administered according to a standardized maximum anchorage control regimen in which the second molars were included in all cases and no headgear was used. Space closure was accomplished by en masse sliding retraction of the anterior teeth using intraarch orthodontic elastomeric chains, producing initial forces of 150–200 g per side, approximately 50 g for each tooth. The elastic chain was replaced every six weeks. All subjects treated with lingual appliances were instructed to wear Class II elastics (3/16- or 1/8-inch medium delivering 70–100 g) for eight hours a day.²⁰ Space closure was accomplished using a 0.016×0.022 -inch stainless steel archwires preactivated with compensating curves (exaggerated Curve of Spee in the maxillary arch wire and a reverse curve in the mandibular arch wire). Lingual space closure was carried out by en masse retraction of the six anterior teeth to avoid opening unaesthetic anterior spaces during the canine retraction phase.

In the lingual cases, the decision to extract first or second premolars was based on the severity of anterior crowding. Anterior crowding greater than six mm inclined toward first premolar extraction. Whenever possible the second premolar was the tooth of choice to maximize esthetics (the extraction site is more visible in lingual treatment) and to prevent the inset bend of the archwire distal to the canine from interfering with space closure.

Radiographic assessment

Serial lateral cephalograms were superimposed according to the method of Pancherz²⁴ (Figure 1). The pre- and post-treatment difference of the distal contact point of the maxillary first molar to a line perpendicular to the occlusal plane through sella (OLp) corresponds to the amount of the mesial (+) or distal (–) movement of the maxillary first molar. This includes maxillary growth that occurred in G4. In this group, the net AL was calculated by subtracting an average annual amount of maxillary horizontal growth (0.5 mm/year for the females and 0.9 mm/year for the males).^{25,26}

Dental cast assessment

Dental casts were measured according to the method described by Ziegler and Ingervall⁶ (Figure 2). The posterior

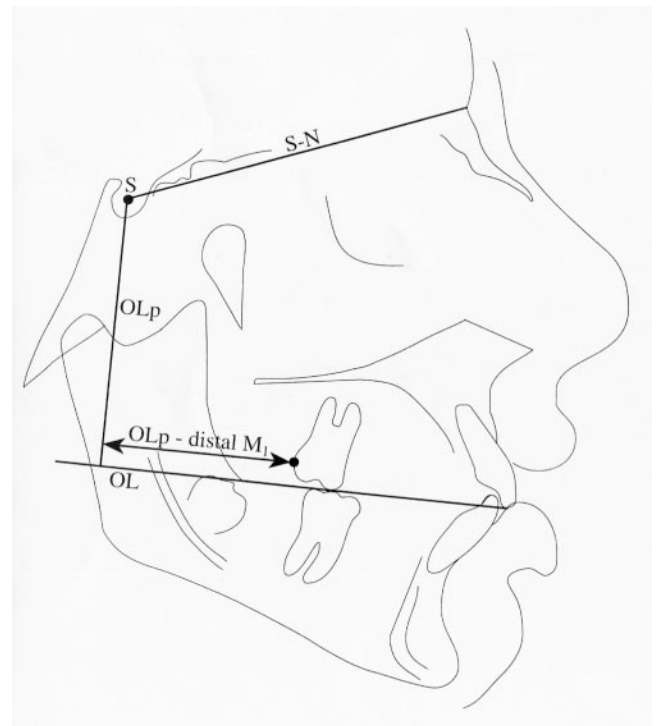


FIGURE 1. The distance of the distal contact point of the maxillary first molar to the occlusal line perpendicular (OLp) was measured from pre- and posttreatment cephalometric radiographs, and the difference (post – pre) was defined as anchorage loss.

ruga point and the mesial contact point of the first molar were demarcated on the right and left quadrants, and the midpalatal raphe was used to construct a median reference line. The referenced casts were photocopied at 200% enlargement. The distance (d) between the projections of the two points to the median reference line was measured for the right (d_R) and left (d_L) quadrants and averaged (Figure 2). The difference between pretreatment “d” and posttreatment “d” was defined as AL. Overjet was measured from the upper and lower dental casts in occlusion. Crowding was measured as the amount of overlap between teeth.²⁷

Statistics

An analysis of variance with repeated measures was performed to determine statistically significant ($P < .05$) differences between the examined groups for three AL factors (extraction site, mechanics, and age). Pearson’s correlation tests examined whether initial crowding and overjet correlated with the amount of AL.

RESULTS

The sex of the individuals was excluded as an AL factor because no dimorphism was found ($P = .397$).

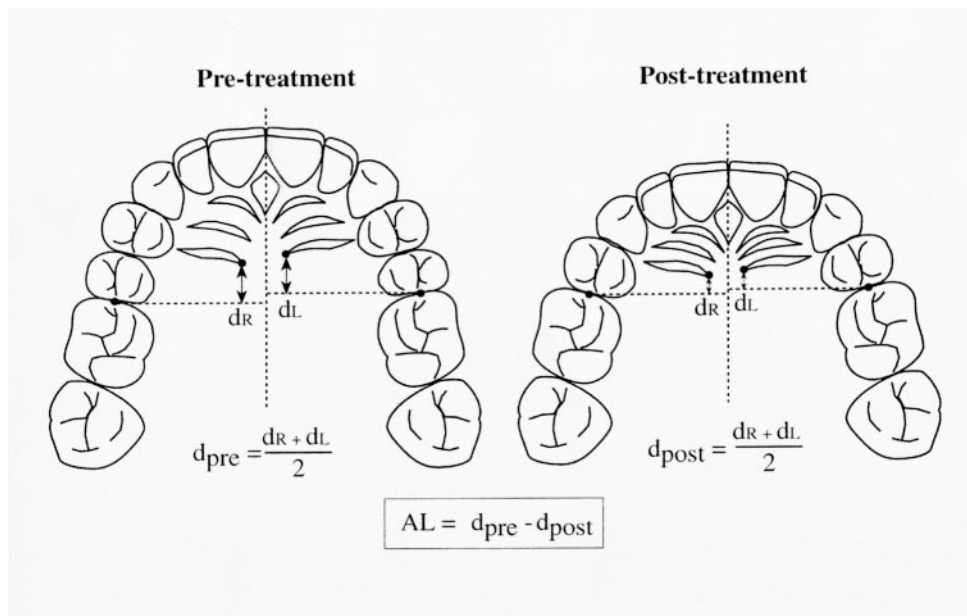


FIGURE 2. (a) Pretreatment dental cast; the distance d was defined as the length between the projection of mesial contact point of the first molar and the projection of the most medial point of the posterior ruga along the midpalatal line. (b) The distance d of the posttreatment dental cast is shorter because of mesial displacement of the first molar and distal migration of the palatal rugae.

TABLE 1. AL for First (G1) Versus Second (G2) Premolar Extraction

Group	n	Age (y)	OLp-M1 Before (mm)	OLp-M1 After (mm)	OLp-M1 Difference (mm)
Cephalogram					
G1	13	24.8 ± 5.7	49.6 ± 9.4	51.4 ± 9.4	1.8 ± 1.4
G2	13	24.4 ± 5.9	45.7 ± 9.6	48.0 ± 9.9	2.4 ± 1.3
<i>P</i>		0.874	0.299	0.372	0.332
Dental cast					
G1	13		7.2 ± 2.9	4.8 ± 2.4	2.4 ± 1.9
G2	10		6.9 ± 2.0	4.0 ± 2.3	2.9 ± 1.6
<i>P</i>			0.771	0.404	0.332

Extraction site—first (G1) vs second (G2) premolar extractions

AL, as measured from the cephalometric radiographs, was 1.8 ± 1.4 mm for G1 and 2.4 ± 1.3 mm for G2. AL, measured from the dental casts, was 2.4 ± 1.9 mm for G1 and 2.9 ± 1.6 mm for G2 (Table 1).

Thus, AL with second premolar extractions was 0.5 ± 1.3 mm greater as measured from the cephalometric radiographs and 0.5 ± 1.7 mm greater when measured from the dental casts. The other two AL factors tested, ie, mechanics (lingual appliances) and age (nongrowing) were similar in these groups.

Mechanics—lingual (G1) vs labial (G3) edgewise appliances

AL, when measured from the cephalometric radiographs, was 1.8 ± 1.4 mm for G1 and 3.0 ± 1.4 mm for G3. AL,

when measured from dental casts, was 2.4 ± 1.9 mm for G1 and 3.9 ± 2.7 mm for G3 (Table 2).

AL was significantly greater in the labial appliance group than in the lingual group when measured from cephalometric radiographs ($P < .05$) but was not significantly greater when measured from dental casts. The other two AL factors tested, ie, age (nongrowing) and extraction site (upper first premolar) were similar in these groups.

Age—nongrowing (G3) vs growing (G4) subjects

The AL, as measured from cephalometric radiographs, was 3.0 ± 1.4 mm for G3 and 3.5 ± 1.6 mm for G4. AL, as measured from dental casts, was 3.9 ± 2.3 mm for G3 and 4.1 ± 2.3 mm for G4 (Table 3).

Thus, the G4 growing patients showed a greater but not significantly greater AL than the G3 nongrowing patients with cephalometric measurements and with dental casts.

TABLE 2. AL for Lingual (G1) Versus Labial (G3) Edgewise Appliance

Group	n	Age (y)	OLp-M1 Before (mm)	OLp-M1 After (mm)	OLp-M1 Difference (mm)
Cephalogram					
G1	13	24.8 ± 5.7	49.6 ± 9.4	51.4 ± 9.4	1.84 ± 1.4
G3	15	20.0 ± 5.4	49.2 ± 12.5	52.3 ± 12.7	3.0 ± 1.4
<i>P</i>		0.25	0.923	0.865	0.042*
Dental cast					
G1	13		7.2 ± 2.9	4.8 ± 2.4	2.4 ± 1.9
G3	11		9.2 ± 2.8	5.3 ± 3.9	3.9 ± 2.7
<i>P</i>			0.097	0.696	0.084

TABLE 3. AL for Growing (G4) Versus Non-growing (G3) Subjects

Group	n	Age (y)	OLp-M1 Before (mm)	OLp-M1 After (mm)	OLp-M1 Difference (mm)
Cephalogram					
G4	33	12.7 ± 2.0	48.3 ± 10.0	51.8 ± 10.2	3.5 ± 1.6
G3	15	20.0 ± 5.4	49.2 ± 12.5	52.2 ± 12.7	3.0 ± 1.4
<i>P</i>		0.0001	0.793	0.919	0.275
Dental cast					
G4	19		9.2 ± 3.5	5.1 ± 3.1	4.1 ± 2.3
G3	11		9.2 ± 2.8	5.3 ± 3.9	3.9 ± 2.3
<i>P</i>			0.994	0.869	0.802

TABLE 4. Comparison of Overjet and Crowding in Relation to the Three AL Factors

	Site of Extraction			Mechanics			Age		
	G1	G2	<i>P</i>	G1	G3	<i>P</i>	G4	G3	<i>P</i>
Overjet (mm)	4.1 ± 2.7	5.0 ± 2.8	0.832	4.1 ± 2.7	5.5 ± 2.6	0.948	5.4 ± 2.5	5.5 ± 2.3	0.995
Crowding (mm)	7.4 ± 1.8	6.6 ± 1.6	0.743	7.4 ± 1.8	6.7 ± 4.2	0.776	6.2 ± 3.7	6.7 ± 2.0	0.876

However, after accounting for the maxillary growth experienced by G4, the net mean AL of G4 was less than that of G3, with no significant net difference. The other two AL factors tested, ie, mechanics (labial edgewise appliances) and extraction site (first premolar) were similar in these two groups.

Overjet and crowding

Overjet and crowding were compared using ANOVA between the three-paired groups of the previously examined AL factors. These comparisons were not significant (Table 4). Pearson's correlation test was performed between initial crowding or overjet and AL for the whole sample. A significant inverse correlation was found between initial crowding and AL for both cephalometric and dental cast measurements (Figure 3; Table 5). The correlation was particularly high for the cephalometric data ($r = -0.66$, $P = .001$). Crowding and overjet were significantly but indirectly and weakly correlated ($r = -0.28$, $P = .009$) (Table 5).

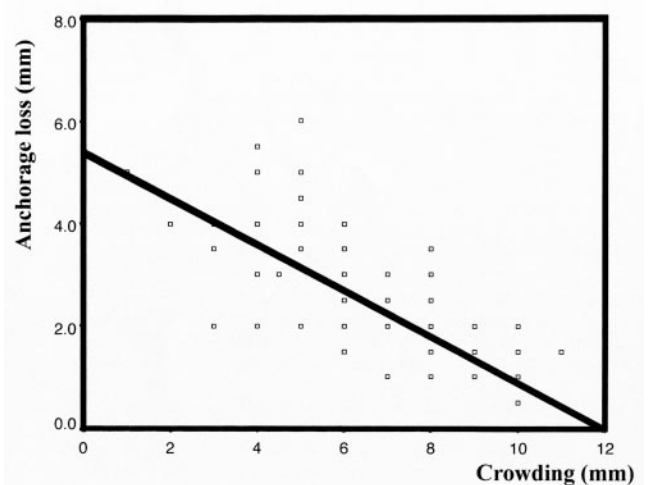
**FIGURE 3.** An inverse correlation developed between initial crowding and anchorage loss measured from cephalometric radiographs.

TABLE 5. Correlation for Initial Crowding and Overjet Versus AL, and Crowding Versus Overjet

	n	Anchorage Loss Cephalogram	n	Anchorage Loss Dental Cast	n	Crowding
Crowding	75	$r = -0.66, P = .001$	53	$r = -0.31, P = .026$		
Overjet	75	$r = 0.27, P = .021$	53	$r = -0.11, P = .449$	90	$r = -0.28, P = .009$

DISCUSSION

The extent of AL was consistently greater when measured from dental casts than from cephalometric radiographs by 0.5–0.6 mm, probably because of posterior displacement of the rugae as the anterior teeth were retracted (Figure 2). Thus, posttreatment *d* (Figure 2b) decreased because of molar mesial movement and posterior displacement of the rugae. Consequently, pretreatment (Figure 2a) minus posttreatment *d* (Figure 2b) increased. Thus, dental cast measurements do not reflect pure molar mesial displacement. In addition, in selecting the most anterior ruga as a reference point, the extent of its posterior displacement was greater than that found for the most posterior ruga, probably because of its proximity to the retracted incisors. These results conflict with studies claiming that the palatal rugae are stable landmarks^{28,29} but are in agreement with other studies that report similar findings.^{30,31} The cephalometric method is more reliable because the reference point (OLp) is located posterior to the examined molar.

Extraction site—first vs second premolar extraction

The long-held dogma that greater AL occurs when second rather than first premolars are extracted^{14,15,17,32} was weakly supported by the present study. AL was only 0.5 mm greater with second premolar extractions when assessed either from cephalometric radiographs or from dental casts. However, this was not significant, suggesting that the location of the premolar extraction site cannot be considered a major AL factor. Statistically, the nonsignificant difference between the two groups could be related to the relative small sample size in this comparison, although the high *P* value suggests a reliable nonsignificant AL difference between the first and second premolar extraction options. Nevertheless, the present finding is supported by Ong and Woods,¹⁶ who reported a 0.2-mm difference. Williams and Hosila¹⁴ compared extraction sites mainly in the lower jaw and reported a difference in AL in second vs first premolar extractions (1.0 mm), which was twice that found in the present study (0.5 mm).

More molar mesial movement in both first and second premolar extractions was reported by Saelens and De Smit¹⁷ (4.4 and 5.3 mm, respectively) compared with the present study (1.8 and 2.4 mm, respectively). This could be related to the use of lingual appliances that contributed to a reduction in molar mesial migration. However, because mechanics was a nonvariable parameter, the inference that the ex-

traction site is a secondary AL factor is probably a valid deduction with regard to maxillary premolars.

Mechanics—lingual vs labial edgewise appliances

The choice of a labial or lingual edgewise appliance demonstrated the greatest AL difference of all two-group comparisons. Cephalometric comparisons (AL = 1.2 ± 2.1 mm, $P < .05$) suggest that this factor plays a more clinically relevant role in controlling AL than the extraction site or patient age. The finding that the lingual edgewise technique demonstrated lower AL suggests that this factor should be studied more closely. The theory of Alexander et al¹² that disocclusion of the posterior teeth due to the bite plane built into the maxillary incisor brackets of the lingual technique decreases resistance to AL is not supported by the present findings. Engagement of second molars in the lingual archwire probably enhanced anchorage, which supports the theory of Storey relating anchorage resistance to root surface areas. Freeman,³³ who calculated this resistance, found that the “anchorage value” (AV) of the maxillary six anterior teeth ($AV_a = 1412$) almost equaled that of the posterior teeth ($AV_p = 1574$) when the second molars were excluded but was almost half when the second molars were included ($AV_p = 2474$).^{2,33} However, in G3 subjects, wearing a headgear was expected to offer greater resistance than inclusion of second molars; but poor patient compliance related to age (20 ± 5.43 years) could explain some of the greater AL displayed by these subjects.

Kurz and Bennett¹³ suggest that the smaller arch perimeter increases the rigidity of lingual archwires, which may increase anchorage control during retraction. The larger slot size of the posterior lingual attachments provides an almost frictionless sliding retraction with no energy burning.^{21,34} Takemoto³⁶ suggests that the anchorage value of posterior teeth in the lingual technique is higher than that in the labial technique because of the nearness of the lingual brackets to the center of tooth resistance. Additionally, the direction of forces during space closure with lingual appliances creates a buccal root torque and distal rotation of the molar crown, which produces cortical bone anchorage.

The average traction force was 75 and 50 g per anterior tooth, in the labial and lingual techniques, respectively. Additionally, because the lingual retraction force is generated by elastomeric chains, their force decay is more than 50% in four weeks.^{36,37} This means that the average force applied during the six-week period (interval between lingual ses-

sions) was about 25 g per tooth. This suggests that, on average, during appointment intervals, the retraction force was threefold lower in the lingual than in the labial technique.

The combination of bidimensional orthodontics with its inherent less friction during sliding mechanics, with light orthodontic forces for space closure, the inclusion of the second molar in the anchorage unit, and the placement of exaggerated curves in both archwires, together appears to be a very efficient method for anchorage preservation. This seems to hold true even in severe Class II cases, regardless of whether first or second premolars are chosen for extraction.

Age—growing vs nongrowing patients

Greater AL was found in the adult group when postero-anterior maxillary growth was compared with the adolescent group. However, the difference between the groups (0.7 ± 1.4 mm) was not significant, which suggests that age, as an AL factor, was secondary to choice of appliance. Nevertheless, a significantly greater AL was found in the adult group of the present study (3.0 ± 1.4 mm) compared with the findings of Harris et al,¹⁹ who reported only a minor AL (0.2 mm), which suggests that this factor merits further study. It should be mentioned that in the latter study,¹⁹ this difference is explained by the fact that the adult subjects wore Class II elastics for a longer time. In the present study, both age groups wore elastics for similar periods. Thus, the results of Harris et al¹⁹ confirm that choice of appliance is a principal AL factor.

Overjet and crowding

The significant indirect correlation found between initial crowding and cephalometric AL and dental cast AL suggests that crowding is another principal AL factor. The present study suggests that the greater the crowding the lower the AL, which contradicts the popular tenet that the more the arch length deficiency the greater the anchorage requirement.^{1,2}

Maxillary arch length deficiency can be expressed as crowding or overjet. According to biomechanical principles, less anchorage is required to unravel crowding than to reduce overjet. Ong and Woods¹⁶ support the interpretation of the present study because, on account of less crowding, they reported greater AL compared with Luppanapornlarp and Johnston.¹⁸

The finding that AL was weakly correlated to overjet also contradicts the above tenet. However, the same overjet can be due to upper incisor proclination or a Class II skeletal condition. The potential for AL is profoundly greater in the latter than in the former, which explains why overjet per se was weakly correlated to AL.

The difference in AL between labial and lingual groups was 1.2 mm. The difference in AL between a moderately

crowded (~ 4 mm) and a severely crowded (~ 10 mm) subject was two mm (Figure 3). This suggests that crowding was more relevant than mechanics as the key AL factor.

CONCLUSIONS

The hypothesis that AL is a multifactorial response was supported by the present study. Although only five AL factors were examined, a regulatory reaction was found. Primary AL factors (crowding and mechanics) affected AL more significantly than did secondary AL factors (age, extraction site, and overjet). A pattern of influence was found, where crowding (inverted influence, ie, the greater the arch length deficiency, the lower the AL) was superior to mechanics (primary AL factors), and extraction site was more influential than age and overjet (secondary AL factors).

The desire to minimize AL is of major concern because residual overjet, noncusp fossa relationships, and deep bite are affected. The study suggests that incorporation of the second molars in the anchorage strategy, low retraction forces, and frictionless mechanics are superior to the conventional anchorage means such as headgear or non en masse retraction.

ACKNOWLEDGMENTS

The authors thank Ms Ilana Gelerenter TAU Statistic Center for statistical analysis, Ms Anna Bahar for graphical help, and Ms Rita Lazar for editorial assistance.

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