CONTINUING EDUCATION ARTICLE

Johnston analysis evaluation of Class II correction in patients belonging to Petrovic growth categories 3 and 5

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Petrovic and Lavergne have proposed a classification of facial growth, consisting of 6 growth categories, according to which patients belonging to growth category 5 at the beginning are supposed to have greater mandibular growth during treatment than patients belonging to growth category 3. We tested this hypothesis with 2 groups of Class II patients: 25 from growth category 3 and 25 from category 5. Both groups consisted of males and females and had starting ages that ranged from 10 to 15 years. Treatment was carried out with a nonangulated edgewise appliance in conjunction with the extraction of four first premolars. The Johnston “Pitchfork” analysis was used to assess treatment changes. It showed that the molar correction was almost identical in amount in growth categories 3 and 5. Its source, however, was not. Differential jaw growth (ABCH) accounted for 75% of molar correction in category 3, but 107.5% in category 5. On average, there was 1.9 mm of extra mandibular advancement relative to cranial base in category 5 as compared with that of category 3. Mandibular advancement was the most important single factor for the molar and overjet corrections in both groups. Treatment success, evaluated according to Lavergne’s treatment objectives, showed that edgewise extraction therapy with headgear is more suitable to patients in category 3 than to the ones in category 5. Further research should explore the treatment methods and goals appropriate to these two growth categories.


Fig 2. Six tissue level growth categories of the mandible with rotational types and corresponding condylion-pogonion (Co-Pog) distances. On the left side, the growth potential of the mandible is below the growth potential of the maxilla, and there is a tendency toward Class II; on the right side, the situation is reverse. The growth potential of the mandible is superior to that of the maxilla and there is a tendency toward Class III. With respect to the neutral growth rotation of the mandible (R), a posterior growth rotation (P) increases the condylion-pogonion distance by opening the angle between the corpus and ramus, whereas an anterior growth rotation (A) decreases this distance by closing the angle. The rotational type P1N should be named P2N.

Md : mandible
Mx : maxilla
Md : without occlusion dependant regulation
Mdb : with occlusion dependant regulation
—— distance Co-Pog for each rotational type
Vertical relation : normal.
the lowest to the highest value of turnover rate, and they tested various methods of categorization. The best fitting method was observed when all of the children were categorized according to the Lavergne and Gasson classification of growth rotations. Petrovic et al detected specific connections between the 6 growth potential categories identified biologically, and the 11 rotational types described cephalo-

**Fig 3.** Identification of positional growth group. ML, mandibular line, the line tangent to the lower border of the mandible through gnathion; NSL, nasion-sella-line, the line through N and S; NL, nasal line, the line through ANS and PNS (ANS, anterior nasal spine; PNS, posterior nasal spine); ML/NSL, angle between mandibular line and nasion-sella-line; NL/NSL: angle between nasal line and nasion-sella-line; $T_1 =$ expected ML/NSL – measured ML/NSL; $T_2 =$ expected NL/NSL – measured NL/NSL; $T_3 =$ measured ANB; expected ML/NSL = 192 – 2 (measured SNB); expected NL/NSL = (measured ML/NSL)/2–7. This cephalometrically based flow diagram allows for the indirect identification of the rotational group, ie, for an indirect recognition of the growth category.15
metrically. This categorization perhaps provides a basis for the biologic heterogeneity of the human growing mandible. The identification of a rotational type through cephalometric analysis is, in fact, an indirect identification of the growth potential and of the responsiveness of a growing child to orthodontic and functional appliances. According to the authors, the existence of facial growth categories is a fortunate situation because it becomes possible to group children who are morphologically alike, who grow alike, and who are more likely to respond in a similar way to a given type of treatment.

The 11 rotational types can be distinguished and designated by a trinomial label. In each label, the 3 successive symbols represent:

1. Mandibular growth rotation (mandibular inclination might be more appropriate because it is dealing with a feature of an individual estimated at a given moment), posterior (P), neutral (R), and anterior (A);
2. A numeric estimate of the difference in growth potential between the mandible and maxilla: 1, mandible = maxilla; 2, mandible < maxilla; 3, mandible > maxilla; 3. The sagittal interjaw relationship: distal (D), normal (N), and mesial (M).

In addition, each rotational type is subdivided according to the vertical dimension into open bite (OB), normal bite (N), or deep bite (DB). Accordingly, 33 rotational groups were described.

In this study, patients belonging to the rotational type R2D were used. And what do these letters mean? The letter R means that these patients have a neutral mandibular growth rotation. The number 2 means that maxillary growth potential is greater than mandibular growth potential. And the letter D means that these patients have a distal sagittal interjaw relationship. We also used A1N and A1D patients. These patients have an anterior mandibular growth rotation represented by letter A. In spite of having an N in their trinomial label A1N patients have a Class II malocclusion. And in both rotational types A1D and

**Fig 4.** Mode of action of treatment objectives over facial type. The ideal objective is to move the patient facial type to the closest “normal” group. But for a certain number of cases this change is not possible, and treatment is not a complete correction but just an improvement of facial type.
A1N, the growth potential of the mandible is greater than maxillary growth potential.

Lavergne and Petrovic\(^{6}\) observed that a given growth potential may give rise in 2 or more rotational types. In other words, a given morphologic pattern (distal, normal, or mesial interjaw relationship) may originate in several ways. As can be seen in Fig 2, the rotational type P2D belongs to growth category 1. The rotational types P1N and A2D belong to the same category (category 2) of the tissue level turnover rate. The rotational type R2D belongs to category 3. The rotational types R3M, A1N, A1D, and P1M belong to the same tissue level category, category 5. Rotational types A3M, and P3M belong to category 6. A clear-cut correlation appears between the alveolar bone turnover rate level and the 6 categories. So far, it is not obvious why some biologic categories split into 2 or even more rotational types.\(^{9}\)

In categories 1, 2, and 3, the tissue level growth potential of the mandible is inferior to that of the maxilla. Accordingly, there is a tendency toward Class II malocclusion. In category 4 mandibular growth equals maxillary growth. In categories 5 and 6, the tissue level growth potential of the mandible is superior to that of the maxilla, and there is a tendency toward Class III, especially in category 6. Globally, there is a satisfactory correspondence between the cephalometric nomenclature and the growth categorization. However, the rotational type P1N should be named P2N, because the growth potential of the mandible is inferior to that of the maxilla\(^{14}\) (Fig 2).

In identifying rotational groups cephalometrically, the recognition of the phenomena named by “letters” is easy.\(^{15,16}\) The difficulty concerns the assessment of the so-called “cephalometric growth potential” designated by the number 2, 1, or 3, which corresponds respectively to mandibular growth potential that is inferior, equal, or superior to the maxillary growth potential. The cephalometric growth potential 2 corresponds to the auxologic (growth) potential 1, 2; or 3; the cephalometric growth potential 1 corresponds to auxologic potential 4 or 5; cephalometric growth potential 3 corresponds approximately to auxologic potential 5 and 6. This correspondence only is valid, however, when the cephalometric categorization is made before initiation of treatment, in view of the observation that no appliance can appear to increase the basic mandibular growth potential, according to research done at tissue and cell level.\(^{13}\)

To detect the growth category directly in patients where extraction of mandibular premolars is clinically indicated, the alveolar bone specimens are collected, put in organ culture for 3 days, and analyzed according to Stutzmann and Petrovic.\(^{17}\) The indirect approach for the identification of growth rotational groups\(^{13,15}\) uses the pretreatment lateral cephalogram, from where we measure SNA, SNB, ANB, ML/NSL (angle between mandibular line and nasion-sella-line), and NL/NSL (angle between nasal line and nasion-sella-line). We used two formulae to find 2 expected angles, and through a flow diagram, we reach the rotational group types (Fig 3).

In 1992, Lavergne\(^{8}\) proposed therapeutic objectives for the facial types (Fig 4). Accordingly, the ideal objective is to change the patient’s facial type to the closest “normal” group through growth rotations. There are 3 groups that have normal, vertical, and sagittal relationships. In group R1NN, mandibular growth equals maxillary growth. In group A1NN, the tissue level growth potential of the mandible is superior to that of the maxilla, but the anterior mandibular rotation will diminish its length. In group P1NN, the growth potential of the mandible is inferior to that of the maxilla, but the posterior rotation of the mandible will increase the overall mandibular length. However, for some patients who have a very severe malocclusion, it is impossible to achieve optimal results (the displacement to a normal group). In these cases, palliative therapeutics, like the extraction or even orthognathic surgery, are chosen to establish a correct interdental relationship.

What happens when, during treatment, the rotational group changes cephalometrically into another group? One possibility is that even with no change in the physiologic basic growth potential, the cephalometric denomination of the rotational group, after treatment, simply may reflect the new appliance-induced anatomic relationship between the maxilla and the mandible.\(^{16}\)

The purpose of this investigation was to evaluate Class II correction in patients belonging to Petrovic growth categories 3 and 5, treated with the standard edgewise appliance. The so-called “Johnston analysis” was used to analyze treatment changes.\(^{19}\)

### MATERIAL AND METHODS

**Sample**

The present investigation consisted of 2 groups of Class II patients: 25 patients from category 3 and 25 patients from category 5. The selection was done con-
secutively, ie, the first 50 patients, male or female, who were encountered from a sample consisting of 800 subjects. The lateral radiographs of 192 Class II patients were traced until we found 25 patients for each category. The main criteria for inclusion in this study were the availability of adequate pretreatment and posttreatment cephalograms and an initial molar relationship that was end-to-end or worse. We did not have a sufficient number of patients in the other growth categories to include them in the study.

Both groups were treated by residents of Methodist University with a standard edgewise appliance, the extraction of 4 first premolars, and extraoral traction (Interlandi Headgear). Several adjuncts (lip bumper, lingual arch, angulated brackets, Class III elastics) were sometimes used for anchorage control in the lower arch. The starting age ranged from 10 to 15 years.

Cephalometric Analysis

The cephalometric tracings in the Petrovic/Lavergne and Johnston analyses were done by hand. No digitization was used. All linear measurements were executed to the nearest 0.1 mm. Angles were obtained to the nearest 0.5°.

The variables for the Petrovic/Lavergne analysis were: SNA, SNB, ANB, ML/NSL, and NL/NSL. To facilitate the classification of the rotational groups and growth categories, a computer program20 developed at our university was used. The regional superimposition used in the Johnston analysis is described in detail elsewhere.19

Treatment Objectives

The determination of the treatment success was carried out according to Lavergne’s treatment objectives18 (Fig 4), based on the rotational group and growth category to which the patient belonged at the beginning of treatment. Treatment improvement was considered to have occurred when a patient changed from category 3 to category 4, and when they changed from deep bite (DB) or open bite (OB) to a normal vertical dental relationship (N) after treatment. The treatment was considered to have failed when a patient changed from category 5 to some other category or when there was a change from a normal vertical incisal relationship to a deep bite or to an open bite.

Error Study

With the aid of a table of random numbers, 15 twofilm series for the Johnston and Petrovic/Lavergne analyses were selected and reanalyzed. Dahlberg’s formula21 was used to calculate the error standard deviations for each variable in the 2 analyses.

Statistical Analysis

The distribution of the patients according to category and rotational group at the beginning and at the end of treatment is summarized in Table I. A univariate repeated measures analysis of variance was used to assess whether variables SNA, SNB, ANB, ML/NSL, and NL/NSL differed among categories and at the

<table>
<thead>
<tr>
<th>Rotational Group</th>
<th>R1NDB</th>
<th>R1NN</th>
<th>R1NOB</th>
<th>R2DDB</th>
<th>R2DN</th>
<th>R2DOB</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2DDB</td>
<td>3 (75%)</td>
<td>0</td>
<td>1 (25%)</td>
<td>5 (83.3%)</td>
<td>0</td>
<td>0</td>
<td>9 (36%)</td>
</tr>
<tr>
<td>R2DN</td>
<td>1 (25%)</td>
<td>2 (100%)</td>
<td>0</td>
<td>1 (16.7%)</td>
<td>3 (60%)</td>
<td>0</td>
<td>7 (28%)</td>
</tr>
<tr>
<td>R2DOB</td>
<td>0</td>
<td>0</td>
<td>3 (75%)</td>
<td>0</td>
<td>2 (40%)</td>
<td>4 (100%)</td>
<td>9 (36%)</td>
</tr>
<tr>
<td>Total</td>
<td>4 (100%)</td>
<td>2 (100%)</td>
<td>4 (100%)</td>
<td>6 (100%)</td>
<td>5 (100%)</td>
<td>4 (100%)</td>
<td>25 (100%)</td>
</tr>
</tbody>
</table>

Table III. Distribution of patients by rotational group in the beginning and in the end of treatment for category 5

<table>
<thead>
<tr>
<th>Rotational group</th>
<th>A1DDB</th>
<th>A1DN</th>
<th>A1NDB</th>
<th>A1NN</th>
<th>A1NOB</th>
<th>A3MOB</th>
<th>R1NDB</th>
<th>R2DN</th>
<th>R3MOB</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1DDB</td>
<td>1 (33.3%)</td>
<td>0</td>
<td>3 (33.3%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4 (16.0%)</td>
</tr>
<tr>
<td>A1DN</td>
<td>2 (66.7%)</td>
<td>1 (100%)</td>
<td>0</td>
<td>2 (33.3%)</td>
<td>0</td>
<td>0</td>
<td>1 (100%)</td>
<td>0</td>
<td>0</td>
<td>6 (24.0%)</td>
</tr>
<tr>
<td>A1DOB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (16.7%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (100%)</td>
<td>0</td>
<td>2 (8.0%)</td>
</tr>
<tr>
<td>A1NDB</td>
<td>0</td>
<td>0</td>
<td>5 (55.6%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5 (20.0%)</td>
</tr>
<tr>
<td>A1NN</td>
<td>0</td>
<td>0</td>
<td>1 (11.1%)</td>
<td>2 (33.3%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3 (12.0%)</td>
</tr>
<tr>
<td>A1NOB</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (16.7%)</td>
<td>2 (100%)</td>
<td>1 (100%)</td>
<td>0</td>
<td>0</td>
<td>1 (100%)</td>
<td>5 (20.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>3 (100%)</td>
<td>1 (100%)</td>
<td>9 (100%)</td>
<td>6 (100%)</td>
<td>2 (100%)</td>
<td>1 (100%)</td>
<td>1 (100%)</td>
<td>1 (100%)</td>
<td>1 (100%)</td>
<td>25 (100%)</td>
</tr>
</tbody>
</table>
II and III show the patient distribution by rotational group at the beginning and at the end of treatment. The number of patients is small when the categories are broken down to the rotational groups, but no comparison was made between these rotational groups. These tables permit the visualization of the individualized change in facial type after treatment, for example, 2 patients that were initially R2DOB (open bite) had their facial type improved to R2DN (normal vertical dimension) after treatment.

The proportions of the sample that were improved in relation to Lavergne’s treatment objectives were 12 of 25 and 7 of 25 for categories 3 and 5, respectively. Thus, 12 patients from category 3 and 7 from category 5 had their initial facial type improved after treatment.

According to the 95% confidence interval, differences between the proportions of improvement for the 2 categories were not statistically significant.

The proportions of patients who got worse were 1 of 25 and 7 of 25 for the categories 3 and 5, respectively. According to the 95% confidence interval, differences between the proportions of worsening for the two categories were statistically significant.

Descriptive statistics for the measurements of the Petrovic/Lavergne analysis are summarized in Table IV. Table V shows the results for the univariate repeated measures analysis of variance.

### Table IV. Means (initial and final of treatment) and standard deviations for the variables of Petrovic/Lavergne analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Initial Mean</th>
<th>Initial SD</th>
<th>Final Mean</th>
<th>Final SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNA (SD_e = 0.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3</td>
<td>83.76</td>
<td>2.76</td>
<td>81.52</td>
<td>2.76</td>
</tr>
<tr>
<td>Category 5</td>
<td>78.32</td>
<td>3.83</td>
<td>76.72</td>
<td>3.88</td>
</tr>
<tr>
<td>SNB (SD_e = 0.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3</td>
<td>77.28</td>
<td>2.74</td>
<td>77.08</td>
<td>3.26</td>
</tr>
<tr>
<td>Category 5</td>
<td>74.12</td>
<td>3.43</td>
<td>74.80</td>
<td>3.61</td>
</tr>
<tr>
<td>ANB (SD_e = 0.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3</td>
<td>6.48</td>
<td>1.69</td>
<td>4.44</td>
<td>1.79</td>
</tr>
<tr>
<td>Category 5</td>
<td>4.20</td>
<td>2.04</td>
<td>1.92</td>
<td>1.86</td>
</tr>
<tr>
<td>ML/NSL (SD_e = 0.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3</td>
<td>34.68</td>
<td>4.73</td>
<td>34.06</td>
<td>5.91</td>
</tr>
<tr>
<td>Category 5</td>
<td>33.40</td>
<td>6.06</td>
<td>31.80</td>
<td>6.20</td>
</tr>
<tr>
<td>NL/NSL (SD_e = 0.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3</td>
<td>8.40</td>
<td>3.54</td>
<td>9.34</td>
<td>3.27</td>
</tr>
<tr>
<td>Category 5</td>
<td>8.94</td>
<td>3.30</td>
<td>9.28</td>
<td>3.17</td>
</tr>
</tbody>
</table>

### Table V. F-ratios for univariate repeated measures analysis of variance

<table>
<thead>
<tr>
<th>Measures</th>
<th>Category</th>
<th>Time</th>
<th>Time × Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNA</td>
<td>29.40**</td>
<td>92.58**</td>
<td>2.57</td>
</tr>
<tr>
<td>SNB</td>
<td>8.92**</td>
<td>2.01</td>
<td>6.74*</td>
</tr>
<tr>
<td>ANB</td>
<td>24.73**</td>
<td>113.68**</td>
<td>0.35</td>
</tr>
<tr>
<td>NL/NSL</td>
<td>1.21</td>
<td>18.88**</td>
<td>3.68</td>
</tr>
<tr>
<td>NL/NSL</td>
<td>0.07</td>
<td>5.24*</td>
<td>1.15</td>
</tr>
</tbody>
</table>

*P < .05; **P < .01.

RESULTS

Patient distribution by growth category at the beginning and at the end of treatment is shown in Table I. Table IV and III show the patient distribution by rotational group at the beginning and at the end of treatment. The number of patients is small when the categories are broken down to the rotational groups, but no comparison was made between these rotational groups. These tables permit the visualization of the individualized change in facial type after treatment, for example, 2 patients that were initially R2DOB (open bite) had their facial type improved to R2DN (normal vertical dimension) after treatment.

The proportions of the sample that were improved in relation to Lavergne’s treatment objectives were 12 of 25 and 7 of 25 for categories 3 and 5, respectively. Thus, 12 patients from category 3 and 7 from category 5 had their initial facial type improved after treatment. According to the 95% confidence interval, differences between the proportions of improvement for the 2 categories were not statistically significant.

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Descriptive statistics for the measurements of the Petrovic/Lavergne analysis are summarized in Table IV. Table V shows the results for the univariate repeated measures analysis of variance. It may be seen that SNA, SNB, and ANB were significantly different, both at the beginning and at the end of treatment when category 3 is compared to category 5. The variables ML/NSL and NL/NSL were not significantly different between patients of categories 3 and 5. All variables showed no significant interaction (Time × Category) with the exception of SNB. Students’ t tests confirmed that SNB was not significantly different (P = .4404) between initial and final for category 3 patients and that it was significantly different for category 5 (P = .0056). This difference (0.68°) for category 5 patients was not clinically significant, however.

Descriptive statistics (means and standard deviations) for the variables of Johnston analysis are shown in Fig 5 and in Table VI, together with F-ratios from the analyses.
of covariance. The difference (1.9 mm) in mandibular advancement relative to cranial base between category 3 (4.1 mm) and category 5 (6.0 mm) was statistically significant ($P < .01$). This extra mandibular advancement resulted in a greater differential jaw displacement (ABCH) in category 5 (4.3 mm) than in category 3 (2.7 mm); the difference (1.6 mm) was statistically significant ($P < .01$). The relationship between the individual components of the molar correction and EGU can be seen in Figs 6 to 10, for those with a significant relationship.

There was no statistically significant difference in net molar correction. Even the bodily and tipping movements were essentially the same in categories 3 and 5. There was a mesial movement of the maxillary molars ($–2.5$ mm in category 3 and $–3.1$ mm in category 5) and of the lower molars ($3.4$ mm in category 3 and 2.9 mm in category 5) in both categories. Even when the movement of the lower molar was studied with respect to EGU and the number of devices used for anchorage, there was no significant difference between the two growth categories.

Skeletal and dental variables showed a significant correlation with EGU. Mandibular advancement $r = 0.6$ relative to cranial base and ABCH $r = 0.6$ bore a positive relationship to expected growth in categories 3 and 5. We also found that maxillary displacement $r = \ldots$
–0.4) and upper molar movement (total: \( r = -0.4 \); bodily: \( r = -0.3 \)) have a negative relationship with EGU: the greater the expected growth, the more the maxilla and upper molars come forward.

**DISCUSSION**

Skeletal and dental changes that accompany edge-wise extraction therapy differ when executed in growth categories 3 and 5. Mandibular advancement (the word advancement is used rather than growth because the present method of regional superimposition cannot distinguish between mandibular growth and bodily functional shifts) was greater in category 5, a finding that corroborate studies done by Petrovic et al, who showed that physiologically determined mandibular lengthening, as seen in untreated patients, increases from growth category 1 to growth category 5. By these results, we can conclude that the analysis made a successful growth prediction, and this prediction says just who is going to have a good growth potential, instead of trying to calculate how many millimeters the mandible will grow in the near future, a type of prediction that still seems impossible. The analysis also seems to be useful in explaining why not all patients respond well to functional appliance treatment: ie, only category 5 patients will show a significant increase in the overall mandibular length.

Considering that mandibular displacement was greater in category 5, we expected that the loss of anchorage would be smaller in this category, given that less mesial movement would be required to correct the Class II molar relationship. There was, however, no statistically significant difference in the movement of the lower molar between categories 3 and 5.
In this study, we observed that loss of anchorage seems to be one of the greatest problems during Class II extraction treatment. Besides a good growth potential, we thus should try to minimize this loss, especially in the upper arch. Johnston\textsuperscript{23} reported 1.8 mm of maxillary anchorage loss and 3.2 mm of mandibular anchorage loss in premolar extraction patients. Harris et al\textsuperscript{31} reported similar findings in adolescent girls: 2.5 mm in the maxilla; 3.7 mm in the mandible. Baumrind\textsuperscript{32} in two stratified random samples of Class II patients, recently found about 6.0 mm for upper anchorage loss in extraction subjects. In the present study, upper molar mesial movement consumed almost 50% (2.5 mm in 3 category and 3.1 mm in 5 category) of the extraction space during treatment.

When the contributions of dental and skeletal changes to the molar correction are compared between categories, we can see that, in category 3, dental change contributed 25%, whereas skeletal change contributed 75% of the molar correction. In category 5, however, dental correction was –0.2 mm (–5%), which was compensated for by differential jaw displacement (ABCH = 4.3 mm), representing 107.5% of the molar correction. Johnston\textsuperscript{23} reported that apical base change accounted for 60% of the molar correction in his study, whereas Harris et al\textsuperscript{31} found that advancement accounted for 70% of the molar correction in adolescents. The importance of mandibular advancement for Class II correction has already been highlighted\textsuperscript{2,33,34} although Hixon and Klein\textsuperscript{35} have stated that growth is not related to Class II correction. Obviously, in the absence of appliances, dentoalveolar compensation\textsuperscript{36} will tend to preserve the occlusal status quo in the face. Given the usual pattern of growth, the skeleton will improve, but the occlusion will remain the same. If, however, the compensations were prevented, a favorable pattern would be able to contribute to the buccal segment correction.\textsuperscript{23} Our results also agree with Rubin\textsuperscript{37} who stated that many of our failures in orthodontics are established the moment we plan treatment and before the first band is cemented. For example, in a Class II case with the extraction of 4 first premolars, if we plan to drive the maxillary molars distally a full cusp and the lower extraction site is consumed by the crowding; if the patient has a poor skeletal growth, we will certainly be disappointed because we will not be able to correct the Class II molar relationship.

There was no statistically significant difference in overjet correction and in the component movements of the upper and lower incisors. However, in category 3 dental movement accounted for 10% (0.3 mm) of the overjet correction; in category 5, the movement of incisors made the overjet correction worse by 22% (–0.8 mm).
mm). We can conclude that ABCH was responsible for 90% of the overjet correction in category 3 and for 119.4% in category 5. Thus, our data support the findings of Paquette et al., who reported that mandibular advancement was the most important net contributor to the overjet correction. Considering that there were no statistically significant differences between the movement of the molars and of the incisors in categories 3 and 5, we cannot corroborate the argument that the more the mandible outgrows the maxilla, the greater the probability that the upper molars and the incisors will tip forward, that the lower incisors will tip lingually, and that lower molar anchorage will be preserved.

Considering that treatment can lead to growth rotations that can change a patient’s rotational group, it was expected that the patients in categories 3 and 5 would have their rotational groups changed after treatment. Accordingly, it was shown that edgewise therapy with premolar extraction tended to produce better results (less worsening in facial type) for patients of growth category 3. These results corroborate Lavergne, who stated that category 3 patients would benefit more from a headgear and fixed appliance treatment, whereas category 5 patients are suited to functional appliance treatment (or both). Actually, further studies should be done in which each category is treated in a different way so that ultimately each category can have its appropriate treatment goals and therapy. In addition, more research is needed on the growth and treatment effects on the TMJ fossa.

Finally, considering the existence of well-defined different facial types for the Class II malocclusion, we can conclude that one approach of treatment may not be effective for all Class II patients. As a result, to study and also to treat Class II malocclusion, it is necessary first to divide patients according to their facial type. When these patients are treated, the clinician should try to improve the patient facial type. If this is not possible, he or she should at least not make it worse.

CONCLUSIONS

1. Molar correction was almost identical in growth categories 3 and 5; however, its source was not. Differential jaw growth (ABCH) accounted for 75% of molar correction in category 3 and 107.5% in category 5. Molar movement accounted for 25% of the molar correction in category 3, but worsened it 4% in category 5. There was no significant difference, either for incisors movement or for overjet correction in both categories. Mandibular advancement was the most important single factor in the molar and overjet corrections.

2. Petrovic/Lavergne analysis made a successful growth prediction of mandibular advancement relative to cranial base.

3. Incisor movement produced little net contribution to the overjet correction.

4. There was no significant difference in anchorage loss between patients of categories 3 and 5.

5. Edgewise extraction therapy is more suitable for patients belonging to growth category 3 than to patients belonging to category 5.

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