DOI: 10.1051/odfen/2017020

J Dentofacial Anom Orthod 2017;20:403

Coronal height after expansion using a Damon® system

B. Ducroz[1], D. Brézulier[2], V. Bertaud-Gounot[3], O. Sorel[4]

[1] Qualified Specialist in Dentofacial Orthopedics, University Hospital Assistant, University of Rennes

[2] Qualified Specialist in Dentofacial Orthopedics, University Hospital Assistant, University of Rennes

[3] University Professor - Hospital Practitioner, University of Rennes

[4] Qualified Specialist in Dentofacial Orthodontics, Professor of Universities - Hospital Practitioner, University of Rennes

SUMMARY

Damon's philosophy is based on gradual tooth movements generated by weak forces. It aims to help surrounding bone to remodel favorably. This way of thinking justifies expansion as an alternative to extraction. However, it is well established that teeth can be moved according to their myo-functional equilibrium and periodontium condition. The aim of this study is to analyze coronal height on various teeth both before and after treatment with the Damon system. Measures have been carried out on virtual models. Results showing a link between expansion and coronal height which increase by 0.65 mm when both the maxillary and mandibular arches are taken into account.

KEY WORDS

Expansion, Damon, Bracket device, Periodontum status, Coronal height

INTRODUCTION

The treatment philosophies of the 21st century tend to preserve dental tissues and try to limit extractions as much as possible. It is well established that orthopedic expansion systems such as disjunctors or even, to a lesser extent, dentoalveolar expansion systems increase the transverse diameter, thereby decreasing in the number of premolar extractions. The Damon® system's main purpose is to limit the use of extractions. It uses the incisivocanine congestion to expand the posterior sectors. Studies have shown that there is indeed an expansion in these areas. Expansion is a common phenomenon in orthodontic treatment but whose noniatrogenic behavior remains controversial, both at the periodontal and dental levels. To date, no studies have examined

Address for correspondence:

Bertrand Ducroz
Patis Tatelin – 35700 Rennes
E-mail: ducroz_bertrand@hotmail.com

Article received: 17-04-2017.
Accepted for publication: 07-06-2017.

the periodontal implications of expansion following treatment with a Damon® system. The objective of this study is to analyze the correlation between coronal height and transverse expansion with the Damon® technique.

MATERIALS AND METHODS

Number of required subjects

The number of required subjects was calculated on the basis of the comparison of a quantitative variable between two groups of subjects. According to the data from a preliminary study, the standard deviations of the heights measured vary from 0.29 to 1.50 (retained value) depending on the teeth.

To show a difference in height of 1 mm between the beginning and the end of the treatment with a power of 0.80; thus, the number of subjects necessary for this study was set at 35.

Inclusion criteria

Fifty consecutively treated cases were selected according to the following criteria: increase of the transverse diameters during the treatment, existence of three sets of models (pretreatment, during treatment, and post-treatment). Post-treatment models are those performed at the end of contention, that is, at least 1 year after the device is removed. Cases of 30 girls and 20 boys were recorded. The treatment starting ages are between 8 and 14.5 years and the ending ages corresponding to the date of registration are between 12 and 19 years. The patients were treated without extractions. Thirty-eight cases were treated exclusively with Damon® multi-attachment therapeutics, whereas 12 underwent an interceptive phase. However, none were treated by an expansive system, such as a Hyrax or Quad-Helix device.

Exclusion criteria

All cases with virtual models that were incomplete or unusable were not included. Similarly, subjects whose erupting teeth rendered the measures unusable were excluded.

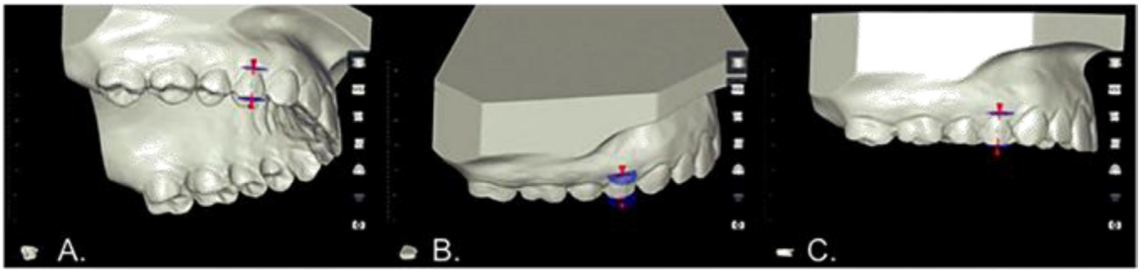

Figure 1
Coronal height measurements are performed three times by varying the inclination of the model. A. Measure at +45°. B. Measure at –45°. C. Measurement at 0°.

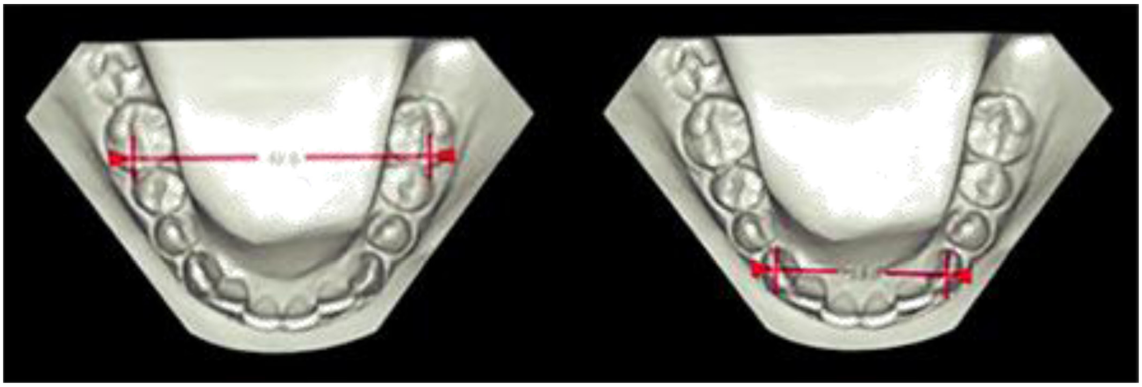

Figure 2
Expansion measurements are performed on the tips of the canines and also, from the top of the mesiovestibular cusp to its contralateral counterpart.

Eventually, our study focused on 43 patients whose casts could be used from the beginning to the end of treatment.

Taking the measurements

The measurements were performed on virtual casts stored on the Bibliocast platform. An integrated caliper tool was used to make the measurements.

The coronal height was measured from the lowest point of the tooth neck to the highest point of the cuspid. We tested the reproducibility of the measurements when the inclination of the model varies with respect to the occlusal plane.

To do this, we performed three measurements per tooth: one at +45°, one at −45°, and a one from the occlusal plane, that is to say a measurement at 0° (Fig. 1). The reproducibility of the coronary height measurements was assessed using the intraclass correlation coefficient (SPSS software version 17.0). The analysis was done with two random variables because the random error can come from either the operator (measurement error) or the subject (defective casting). The reproducibility of the measurements is excellent with intraclass correlation coefficients >0.99. The measurement protocol is reliable.

Regarding expansion measures, intercanine and intermolar distance measurements were made from cuspidal tip to cuspidal tip of the contralateral tooth. For the molar sector, mesiovestibular cusps were taken into account (Figure 2).

Statistical analysis

Coronal heights at the beginning and end of treatment and expansion were compared using a Student's test. The correlation between coronal height difference before and after treatment and expansion was analyzed by a linear regression test using the same software. The risk of primary errors was set at 0.05.

RESULTS

Cross-sectional expansion

The intercanine and intermolar distances at the beginning and at the end of the treatment were compared initially. The measurements given here are the average mandibular and maxillary intercanine and intermolar distances. On the maxillary arch, we note that the average arch width increases from 42.51 to 45.26 mm. This 2.7-mm increase in the transversal dimension is statistically significant ($p < 0.0001$). At the mandibular arch, the expansion results in an average width that goes from 35.76 to 37.28 mm. The 1.5-mm expansion is statistically significant ($p < 0.003$).

The average of these values was calculated, it served as a basis for the correlation test with overall gingival height (see below). Thus, the average arch width (maxillary and mandibular combined) increases from 39.14 to 41.27 mm. Note that the difference of 2.13 mm is statistically significant ($p = 0.0002$) (Figure 3).

Coronal heights

Similarly, maxillary and mandibular coronal height measurements were taken individually, and the mean was calculated to test the coronal expansion-height correlation.

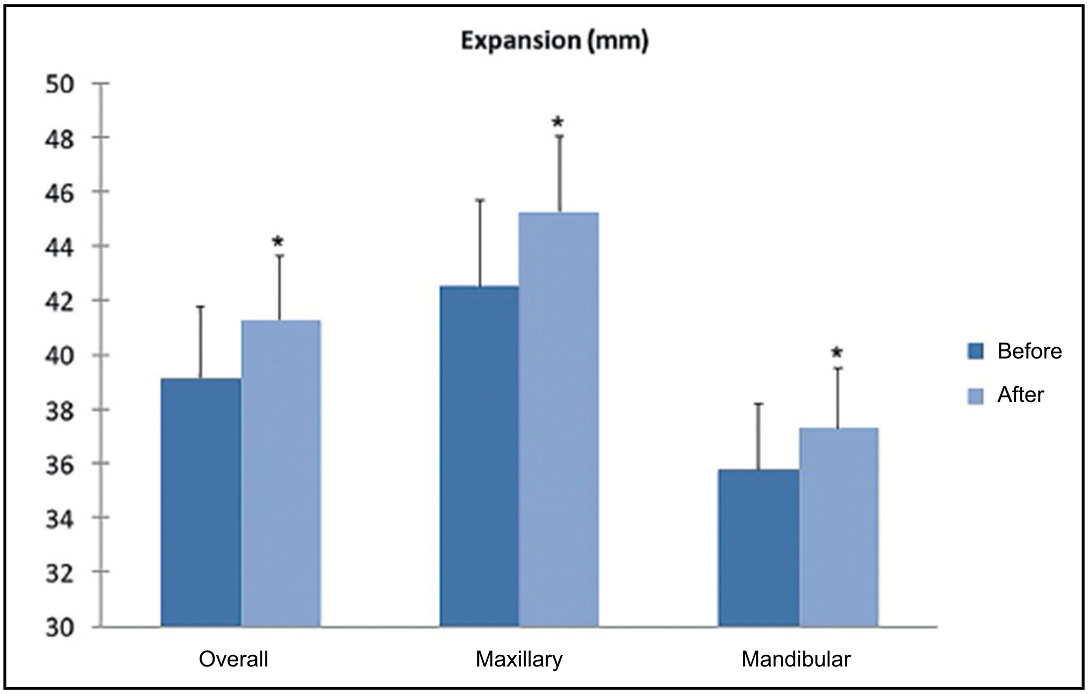

Figure 3
*Mean transverse distance in mm of the maxillary and mandibular arches before and after treatment and algebraic averages of these values. *Statistically significant difference with p < 0.05.*

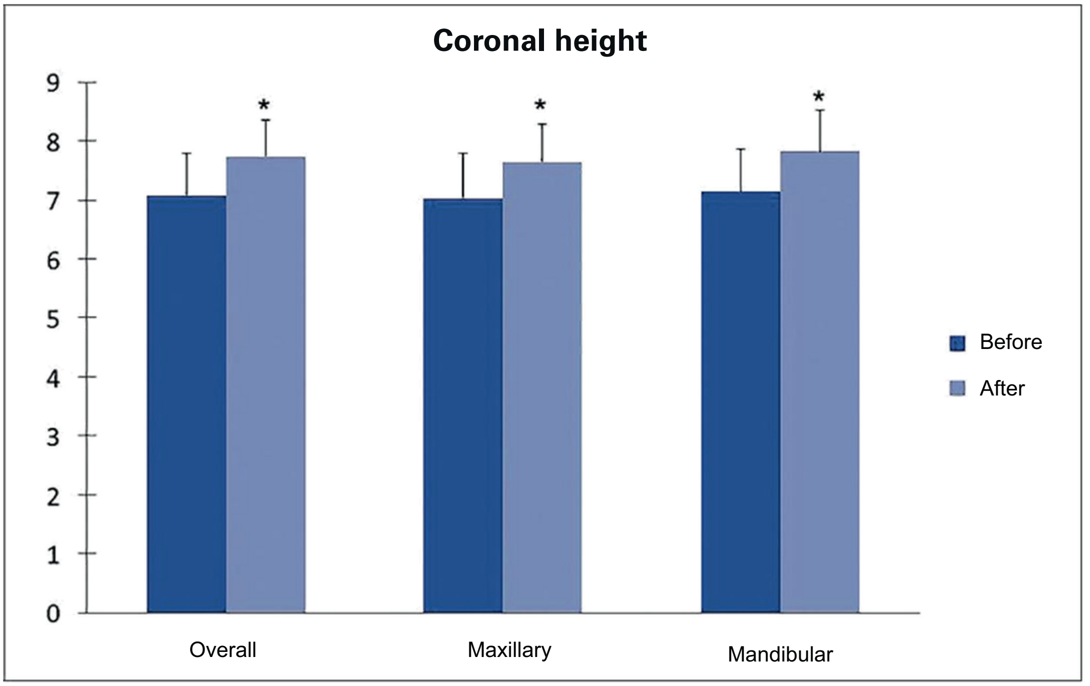

Figure 4
*Mean coronary height in mm of maxillary and mandibular arches before and after treatment and algebraic averages of these values. *Statistically significant difference with p < 0.0001.*

The coronal height of the maxillary teeth increased from 7.02 to 7.65 mm, an increase of 0.63 mm (p = 0.0001). On the mandible, the height variation of 0.68 mm (7.14 mm at the start of treatment and 7.82 mm at the end of treatment) is statistically significant ($p < 0.0001$).

With the maxilla and mandible combined, the mean increase in coronal height is 0.65 mm (from 7.08 to 7.73 mm) which is also statistically significant ($p < 0.0001$) (Fig. 4).

Correlation test between expansion and coronal height

The quantitative variables extracted previously are decreased in percentages (percentage of increase relative to the initial dimension). Therefore, the measures of expansion and coronal height have a common order of magnitude. Average expansion of both arches is 5.8%, while coronary heights increase by 9.6%.

A linear association between increases in coronal height and expansion (in percentages) is clearly visible ($p < 0.008$). The correlation coefficient is small (0.16) but not zero (Figure 5).

Considering only the mandibular arch, the linear regression rule does not show any link between the increase in coronal height and the increase of the arch width ($p > 0.05$), the coefficient of correlation is 0.09. There is no statistically significant relationship between the increase in coronal height and mandible expansion (Fig. 6).

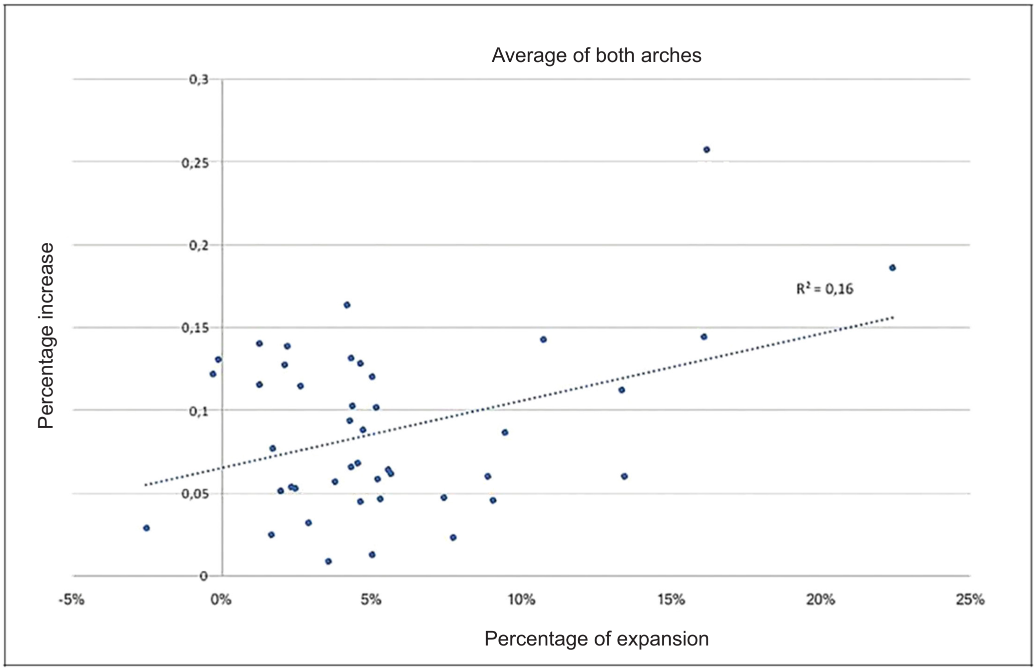

Figure 5
There is a correlation between expansion and increased coronal height. The correlation coefficient is low.

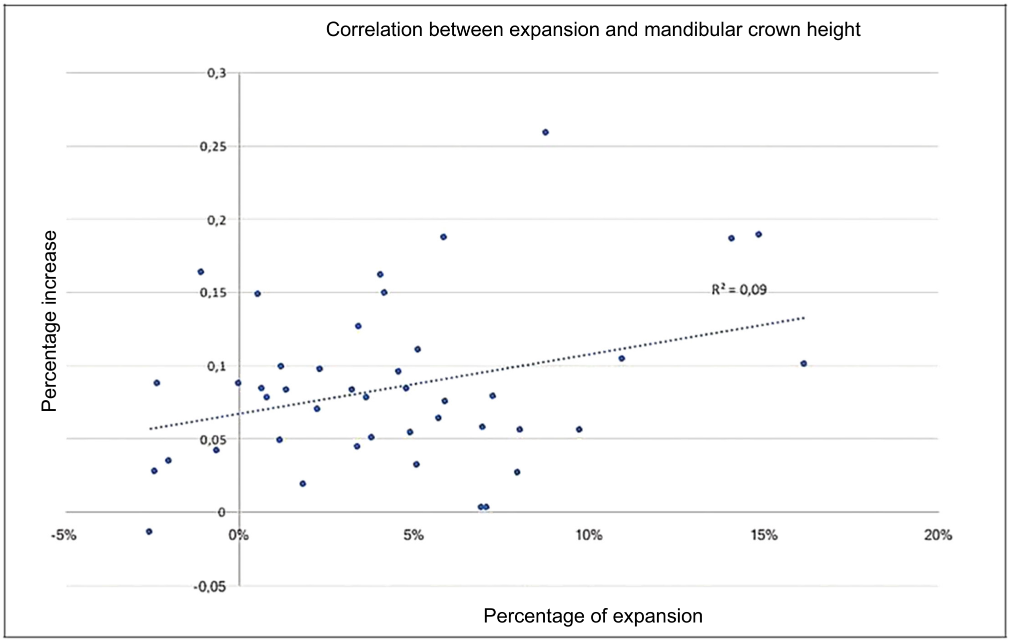

Figure 6
In the mandibule, no correlation can be demonstrated.

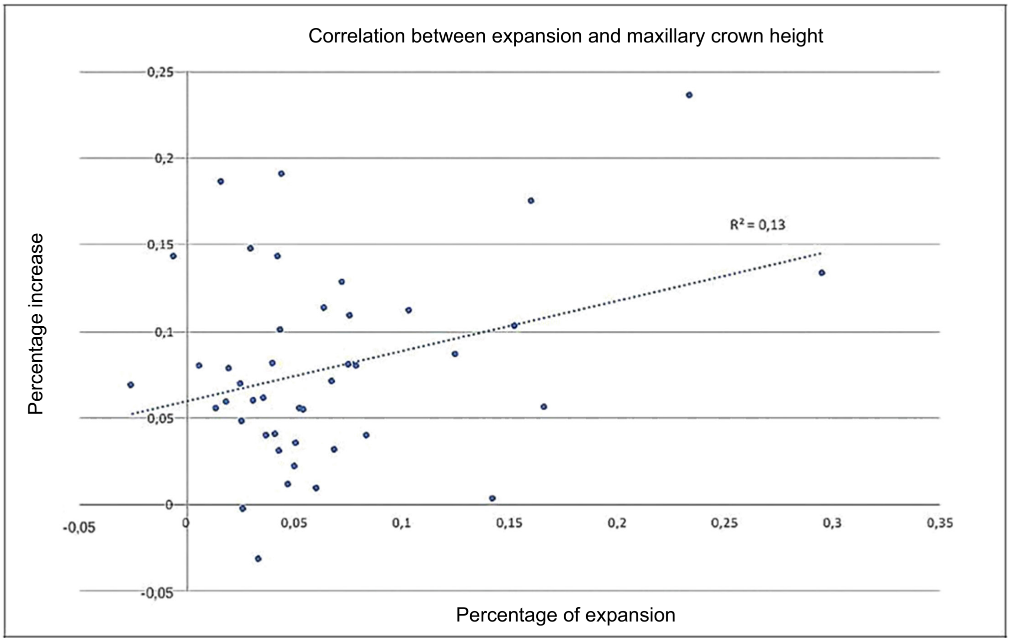

Figure 7
In the maxillary, linear regression shows a link between expansion and coronary height variation.

In the maxilla, the linear regression rule shows a link between expansion and coronary height variation ($p = 0.02$) with a correlation coefficient of 0.13 (Figure 7).

DISCUSSION

The increase in coronal height corresponds to an apical migration of the zeniths of the necks of the tooth. The latter is on average 0.65 mm in our study, considering both the maxillary and mandibular teeth. The literature[1] shows, on a control group receiving orthodontic treatment without expansion, an increase in the coronal height on the order of 0.03 mm. Our results can be compared to those of Bassarelli. The average expansion in his study is 3 mm with a coronal height change of approximately 0.16 mm. Our study shows less expansion (2.14 mm) but with a higher coronal height increase (0.65 mm). This highlights a significant increase in coronal height in our study. On the other hand, Zachrisson[7] and Pearson[4] demonstrated, 2 years after fixed orthodontic treatment, an attachment loss of 0.41 mm (compared to a control group with a 0.11 mm loss of attachment). This value of 0.41 mm shows a significant iatrogenic effect of the device very likely due to the difficulty of ensuring the necessary hygiene. This data is relatively close to the overall coronal

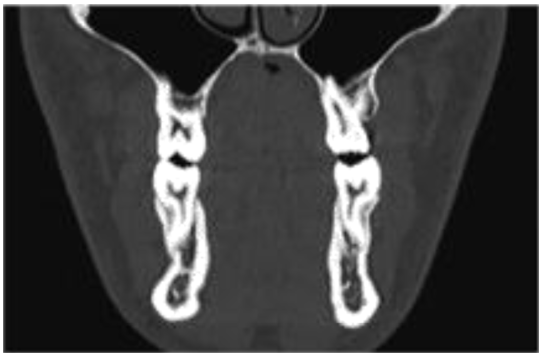

Figure 8
CT scan at the level of the first molars. Note the fineness of the maxillary external cortex and the short distance separating it from the tooth.

height increase observed in our study (0.65 mm). Therefore, the iatrogenic effect of the sealed or bonded multiring orthodontic devices is an important factor in increasing coronal height.

At this level, it is necessary to differentiate between the maxillary arch and the mandibular arch. In the mandible, the average change in coronal height is 0.68 mm. This variation is not correlated with the amount of expansion. It is however greater than that observed without treatment on the one hand, and also greater than that observed in the control group by Bassarelli. The changes in the coronal height in the maxillary teeth differ from those observed in the mandible. The evolution of the coronal height is statistically related to the degree of expansion but in a moderate way. The maxillary periodontium appears to be more sensitive to expansion than its mandibular counterpart.

Maxillary expansion is not comparable with mandibular expansion. The position before treatment in the lateral sectors is either a normal third-order inclination, or in compensation by a coronovestibular version. In this study, no account was taken of tooth version movements that may affect coronal height and the extent of expansion[6]. However, it is necessary to consider the third-order inclination of the teeth to definitively conclude on the potential effects of expansion, but few studies focus on this point. Nevertheless, the observation of the casts shows in a very large number of cases in occlusal view, vestibular surfaces which, apparent at the beginning of treatment, disappear after treatment. Endoalveolia, marked by a palatal version of alveolar processes, is the least encountered. The expansion movement does not correspond to the one observed in the mandible where the vestibular version is most often encountered. On the other hand, the maxillary arch is directly affected by the jugal musculature and the buccinators, due in particular to its greater distance from the mandible. This phenomenon is particularly noticeable in the lyre-shaped arches[2].

Although coronal height measurement may be questionable in estimating attachment loss, the fact remains that its increase reflects a decrease in periodontal coverage. When choosing the measurement method, it was assumed that there is a bias due to gingival recessions that increase the coronal height of the teeth between the casts before and after treatment. Similarly, the measurement of the casts is likely to be less precise. Indeed, it does not take into account attrition or even gingival hyperplasia. In addition, it does not take into consideration the presence of periodontal pockets. Therefore, even if the periodontal tissue appears intact, there may be underlying bone loss that is detectable only during the clinical examination[3].

The natural development of teeth, from childhood to adulthood, results in the growth of dento-alveolar processes with an increase in coronal height. Once the tooth is occluded, during adolescence, the coronal height increases from 0.58 to 0.85 mm depending on the teeth and the individual[5].

Gingival maturation in adults leads to a coronal height increase at the molar level of 0.4 mm and 0.19 mm at the incisal level over the course of 10 years[5]. The phenomenon is described as the passive eruption that compensates for the phenomena of attrition. The order of magnitude of the change in coronal height in adolescence, which is estimated between 0.58 and 0.85 mm corresponds to that of our study (0.65 mm), which takes place over the course of 2–4 years.

The hypothesis that can be formulated is the following: the increase in coronal height is only related to maxillary expansion. The anatomical conditions of the dentoalveolar bone environment should be considered.

The analysis of tomodensitometric sections at the level of the molars shows great differences between the two arches (Figure 8).

The cortex is thicker at the mandible and the distance separating it from the tooth is greater. In the maxilla where the cortex is thinner, we cannot prevent fenestration phenomena by bone remodeling.

CONCLUSION

The average increase in coronal height is 0.65 mm in our study. This value following orthodontic treatment may appear relatively significant.

On the other hand, even if the average increase in maxillary coronal height is lower in the mandible, it is only in the maxilla that we find a weak correlation with the measured expansion. The initial position of the teeth in the maxilla and the mandible is not equal. It seems that the extent of the vestibular version is, therefore, greater in the mandible at the end of treatment.

A longer-term study is needed to determine whether the increase in coronal height after treatment is an indication of the future development of the periodontium or an irreversible iatrogenic effect.

In addition, the study does not take into account differences in the amount of dental crowding between patients, but this parameter is affected when using the Damon technique®, especially when there is a possible indication of avulsion.

ACKNOWLEDGMENTS

The authors thank Dr. Bernard Nourry for having made available 50 cases treated consecutively with the Damon technique®.

Conflict of interest: The authors declare that they have no conflict of interest.

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