INFLUENCE OF STRAIGHT-PULL HEADGEAR ON THE ERUPTION PATTERN OF MAXILLARY CANINES: A RETROSPECTIVE STUDY

Aim: To evaluate the effect of the straight-pull headgear and activator (Andresen type) treatment on the eruption pattern of impacted maxillary canines. Methods: Mesiodistal positional, angular, and vertical changes of impacted canines were evaluated and statistically analyzed in pre- and posttreatment panoramic radiographs of 22 patients (12 treated with combination headgear, 10 treated with an activator). Results: Eruption of the permanent canines in the group treated with straight-pull headgear was significantly more successful (88%) than in the group treated with an activator (62%). Conclusion: Mesiodistal and vertical crown position, as well as angulation of canines, differ significantly between subjects treated with straight-pull headgear or an activator. World J Orthod 2009;10:125–129.

The canine is the second most commonly impacted tooth (after the third molar), with a rate ranging from 1% to 3%. Maxillary canine impaction is complex in its etiology, severity, and response to preventive treatment. Any prediction is difficult, which constitutes a dilemma for many orthodontists.

The variables that influence the possible success in treating patients with impacted canines are dental age; severity of displacement in relation to the occlusal plane, mesiodistally, in angulation, or transversely; location of the cusp tip and its relationship to the adjacent lateral incisor; as well as transposition with a lateral incisor or first premolar.

Currently, the most common preventive treatment, as recommended by Lappin, is to extract the deciduous canine with the anticipation that the permanent canine resolves its unfavorable position.

Two relevant studies have reported success with this treatment approach, observing eruption to occur in 78% (Ericson and Kurol) and 62% (Power and Short) of patients. The latter study also reported an improved canine position in an additional 19% of all affected patients. However, the extraction of deciduous canines aiming at stimulating a spontaneous eruption of an (potentially) impacted permanent canine must be based on the dental age of the affected patient.

Leite et al suggested in a patient report that the headgear used could have influenced the eruption pattern of the intraosseous localized maxillary canine. This headgear was inserted to correct the existing Class II occlusion by moving the buccal segments distally. At the same time, the authors intended to gain more space in the dental arch.

Leonardi et al and Baccetti et al found that the use of a cervical-pull headgear in addition to the extraction of the preceding deciduous canine induces a successful eruption of the permanent canines in 80.0% and 87.5% of affected patients, respectively.

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The mechanism by which molar head-gear has an effect on the eruption of a displaced canine is not yet clearly explained in the relevant literature. Thurow stated that this influence is probably mediated through a combination of tension on the fibrous matrix of the bone and movement of the entire maxilla.

This study aims to evaluate whether straight-pull headgear or an activator improves the intraosseous position of displaced canines and which of the two appliances is more effective.

**MATERIALS AND METHODS**

**Sample**

This retrospective study is based on the pre- and posttreatment panoramic radiographs of 22 patients from the Department of Orthodontics, University of Catania, Catania, Italy. Twelve of these patients were treated with straight-pull headgear and the remaining 10 with an activator (Andresen type). They all had to meet the following criteria: (1) at least one impacted maxillary canine (unilaterally unerupted canines were considered impacted if the contralateral canine had erupted at least 6 months prior; bilaterally unerupted canines were considered impacted if the normal eruption age had been passed by at least 1 year and both maxillary second premolars had erupted at least 8 months before); (2) similar dental age (10 to 12 years); (3) pre- (T1) and posttreatment (T2) panoramic radiographs of good quality; (4) skeletal Class II occlusion; and (5) previous extraction of the primary canine(s).

The following exclusion criteria were applied: (1) complex craniofacial deformities or syndromes; (2) mechanical obstacles to the eruption such as cysts, odontoma, or tumors; and (3) trauma, agenesis, or supernumerary teeth in the canine region.

The pretreatment mean age of all patients was 10.6 ± 1.0 years and 13.0 ± 1.0 years at posttreatment.

The patients treated with straight-pull headgear were instructed to wear their extraoral traction for 12 to 14 hours per day. The applied force was measured with a tension gauge and amounted to 150 cN per side for the high- and cervical-pull component. The inner bow was not expanded, and the outer bow was adjusted parallel to the occlusal plane.

The patients with the activator were asked to wear their appliance 4 hours per day in the first week, 8 hours per day in the second week, 12 hours per day in the third week, and 24 hours per day thereafter (with the exception of eating and participating in certain sports) until the completion of treatment.
Radiographic and cephalometric analysis

All panoramic radiographs were viewed under standardized conditions and traced onto acetate tracing paper with a 0.3-mm pencil.

Reference lines included the occlusal plane traced from the mesial cusp of maxillary first molars to the incisal margins of the central incisors and a vertical line that bisected the long axes of the maxillary central incisors. If the central incisor roots were asymmetrically angulated, the vertical line passed through the intermaxillary suture. Also, the axes of the canines, lateral incisors, and first premolars were drawn.

The following variables were studied:

- Alpha angle (α): canine inclination to the vertical line on the panoramic radiograph (Fig 1)
- Beta angle (β): canine inclination to the axis of the lateral incisor on the panoramic radiograph (Fig 1)
- Eta angle (η): canine inclination to the axis of the first premolar on the panoramic radiograph (Fig 1)
- d: perpendicular distance from the canine cusp tip to the occlusal plane on the panoramic radiograph (Fig 1)
- Zone: mesiodistal position of the canine tip in relation to the adjacent teeth on the panoramic radiograph (Fig 2)

• Canine inclination (CI): angle of the canine axis to a straight line through both suborbitale points similar to Bjerklín and Kuroi (a 90-degree angle thus corresponds with a canine perpendicular to the reference plane [Fig 3]).

Measurements reliability

To evaluate the interoperator error, all tracing and measurements were repeated on six randomly selected panoramic radiographs after an interval of at least 12 days. The percentage error was calculated using Dahlberg’s formula (mean square error $S^2 = \sqrt{\sum d^2/2n}$ where $d$ = difference between repeated measurements, $n$ = number of evaluated radiographs). Pearson r correlation coefficient indicated a high correlation between the values obtained ($r = .92$).

Statistical analysis

All statistical analyses were performed using SPSS (SPSS, Chicago, Illinois, USA). For each variable, the arithmetic mean and the standard deviation were calculated.

A two-tailed t test for paired data was used to determine statistical significant changes between the pre- and posttreatment situation in the two groups. Significance was assessed at $P < .05$.  

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Angular and positional changes in impacted canines between T1 (before) and T2 (after) straight-pull headgear treatment (compare to Figs 1 to 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>T1 Mean</td>
</tr>
<tr>
<td>α angle (degrees)</td>
<td>32.3</td>
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<tr>
<td>β angle (degrees)</td>
<td>42.8</td>
</tr>
<tr>
<td>η angle (degrees)</td>
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<td>Cl angle (degrees)</td>
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<tr>
<td>d (mm)</td>
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<td>Zone (1 to 5)</td>
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Mean, arithmetic mean; SD, standard deviation; NS, not significant.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Angular and positional changes in impacted canines between T1 (before) and T2 (after) activator treatment (compare to Figs 1 to 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>T1 Mean</td>
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<tr>
<td>α angle (degrees)</td>
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<tr>
<td>β angle (degrees)</td>
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<tr>
<td>η angle (degrees)</td>
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<td>Cl angle (degrees)</td>
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<td>d (in mm)</td>
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<tr>
<td>Zone (1 to 5)</td>
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</tr>
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</table>

Mean, arithmetic mean; SD, standard deviation; NS, not significant.
RESULTS

The variables $\alpha$ angle, $\beta$ angle, CI angle, $d$, and zone exhibited statistically significant changes between T1 and T2 in the straight-pull headgear group (Table 1). In the activator group, only $d$ and zone revealed significant differences between T1 and T2 (Table 2). The number of patients with successful eruption of the permanent canines in the straight-pull headgear group was significantly greater than in the activator group. Finally, $\alpha$ angle, $\beta$ angle, and CI angle were significantly different between the two groups (Table 3).

DISCUSSION

In this study, 88% of the straight-pull headgear–treated patients’ canines erupted spontaneously as compared to only 62% in the activator patients. The results of the present study are slightly more favorable than those reported by Olive,\(^{15}\) who found that 75% of the canines erupted after orthodontic treatment with fixed appliances to create space in the maxillary arch followed by the extraction of the primary canines. Kettle\(^{16}\) and Jacobs\(^{17}\) also reported that the success rate of canine eruption was increased by combining extraction of the deciduous canines with distal movement of the maxillary buccal segments or even the extraction of a permanent posterior tooth. Apparently, straight-pull headgear restrains the maxillary posterior segment from moving mesially, thus maintaining the space necessary for an unimpeded canine eruption.\(^9\)

It cannot be excluded that the combination of headgear could also have a direct influence on the eruption of an impacted canine. Thurow\(^{11}\) believes that this influence is mediated through a combination of tension on the fibrous matrix of the bone and a distal movement of the entire maxilla. An experimental study in rats showed that an orthodontic force affects not only the periodontal ligament of the teeth to which the force is applied but also that of more distant teeth.\(^{18}\)

CONCLUSION

The following conclusions can be derived from the present study:

- The application of straight-pull headgear induces a successful eruption of the permanent canine in 88% of the affected patients.
- There are significant differences in the eruption pattern between patients treated with straight-pull headgear and those treated with an activator.
REFERENCES