Surgical exposure, orthodontic movement, and final tooth position as factors in periodontal breakdown of treated palatally impacted canines

Jerusalem, Israel

Twenty-three patients who had completed orthodontic treatment for the resolution of unilateral palatal canine impactions were examined 2.3 years (mean) after all appliances were discarded. The patients were divided into two groups on the basis of whether the surgical exposure was “light” or “heavy.” The whole group was also divided according to the type of orthodontic movement that was carried out—“light” for tipping, extrusive, and rotating movements and “heavy” for root movements. Final position of the teeth was classified as ideal or incomplete if rotations or spaces were present. The results showed marked deteriorative changes where the surgery had been more radical and where the tooth movement involved active alteration of root position. No change due to abnormal tooth position was seen. It is suggested that, in these cases, surgical procedures be limited in scope and that exposure of the cementoenamel junction be avoided.

Key words: Palatally impacted canines, surgical exposure, orthodontic movement, loss of bone support

The orthodontic alignment of palatally impacted canine teeth is a complex treatment involving close cooperation between the orthodontist and the oral surgeon. Many different variations have been suggested in the surgical procedure involved, from the more radical exposure1-3 to the minimal one.4 Most frequently the decision as to which procedure is used is in the hands of the surgeon, and this has been encouraged.5

In an effort to gain an insight into this hitherto unresearched area, Wisth and associates6 compared two variations of a single method of surgical exposure which differed in one detail only. In one group, after exposure of the tooth and removal of overlying bone, the flap was sutured back, whereas in the second group the flap was reduced in size and the tooth was left exposed.

Following exposure, many canines are seen to erupt with considerable speed and, as they do so, their buccolingual position improves. With minimal treatment only, they are brought into alignment.7 On the other hand, there are others for which extensive treatment is needed.8 This involves initially extruding them vertically downward and then tipping their crowns labially into the line of the arch. Subsequently, they may require rotation, uprighting, and sometimes buccal root torque. We considered that the difference in mechanotherapy needed for these two extremes could have ramifications with respect to the final periodontal status of the teeth concerned.

Among the etiologic factors often listed for the existence of periodontal disease is tooth irregularity. While this contention has been disputed,9 it is still reiterated in standard texts.10,11

The purpose of this article was to investigate the effects that surgical exposure, orthodontic movement, and final tooth position have on the supporting tissues.

MATERIALS AND METHODS

The 23 patients who had been orthodontically treated for unilateral impaction of a maxillary canine, described in an earlier communication,12 provided the data material for the present investigation. The treatment had consisted of orthodontic reopening of the canine space and surgical exposure of the buried tooth, with cementation of an orthodontic band at the time of operation when indicated. Light orthodontic traction
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Periodontal breakdown of treated palatally impacted canines

Table I. Comparison of the variables between light and heavy exposure

<table>
<thead>
<tr>
<th></th>
<th>Mean light (N = 13)</th>
<th>SD</th>
<th>Mean heavy (N = 10)</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>P11.c</td>
<td>1.38</td>
<td>0.73</td>
<td>2.75</td>
<td>0.61</td>
<td>2.46</td>
</tr>
<tr>
<td>P11.a</td>
<td>1.29</td>
<td>0.60</td>
<td>1.76</td>
<td>0.69</td>
<td>1.69</td>
</tr>
<tr>
<td>Gl.c</td>
<td>1.05</td>
<td>0.75</td>
<td>1.25</td>
<td>0.55</td>
<td>1.11</td>
</tr>
<tr>
<td>Gl.a</td>
<td>0.92</td>
<td>0.60</td>
<td>1.19</td>
<td>0.47</td>
<td>1.21</td>
</tr>
<tr>
<td>PD.c</td>
<td>2.29</td>
<td>0.64</td>
<td>2.81</td>
<td>0.71</td>
<td>1.82</td>
</tr>
<tr>
<td>PD.a</td>
<td>2.35</td>
<td>0.44</td>
<td>2.61</td>
<td>0.55</td>
<td>1.92</td>
</tr>
<tr>
<td>BS.m</td>
<td>92.61</td>
<td>3.92</td>
<td>87.20</td>
<td>4.18</td>
<td>3.18*</td>
</tr>
<tr>
<td>BS.d</td>
<td>91.23</td>
<td>5.23</td>
<td>85.90</td>
<td>5.72</td>
<td>3.40*</td>
</tr>
<tr>
<td>BS.t</td>
<td>91.92</td>
<td>4.03</td>
<td>86.50</td>
<td>4.39</td>
<td>3.40*</td>
</tr>
<tr>
<td>Att.c</td>
<td>5.00</td>
<td>1.68</td>
<td>3.80</td>
<td>1.81</td>
<td>1.62</td>
</tr>
</tbody>
</table>

Key to symbols:
P11 = Plaque index.
GI = Gingival index.
PD = Pocket depth.
c = Relating to the canine.
a = Relating to the adjacent area.
BS = Percentage bone support.
m = Mesial side.
d = Distal side.
t = Total.
Att.c = Attached gingiva on the canine.
*p < 0.05.
**p < 0.01.

(20 to 30 gm) was used to bring the tooth to its place in the arch and was combined with treatment of the overall malocclusion by means of multibanded appliances in all cases, with or without the remedial extraction of permanent teeth as indicated in each case.

In those cases in which an attachment was placed on the exposed canine, the standard procedure was to have adapted a preformed band for the contralateral erupted canine, prior to the day of operation, and to cement this to the buried canine at the time of its exposure, with a small eyelet welded to the labial and palatal aspects of the tooth as close as possible to the gingival edge of the band. A fine soft steel ligature was then threaded through the eyelet, lightly twisted, and curled into a hook at its exit through the surgical flap. Where the canine was sufficiently superficial, a wedge-shaped piece of tissue was removed from the flap and the tooth was covered with a pack, whereas a deeper-situated tooth was re-covered with the full flap sutured back to its former place.

The extent of surgical exposure was described in two ways. Light exposure was defined as exposure of the tooth to a degree adequate for placement of the prepared band but coronal to and not exposing the cementoenamel junction (CEJ). Thirteen cases of this type were examined. Heavy exposure involved the removal of enough bone to allow for the complete curetting of the follicular sac of the unerupted tooth, thereby fully exposing the CEJ and occasionally a limited area of root surface. This was performed in 10 cases.

The degree of orthodontic movement was also described as light or heavy, with light movement encompassing tipping, rotatory, and extrusive components and heavy movement encompassing the components of root movement in uprighting and torquing, with or without light movements. Here, too, 13 cases were treated with light movement and 10 with heavy movement.

The clinical and radiographic recordings made included the plaque index for the canine tooth (P11.c) and that for the adjacent teeth (P11.a), the gingival index (Gl.c and Gl.a), the pocket depth (PD.c and PD.a), the attached gingiva (Att.c), the bone support on the mesial side (BS.m), the distal side (BS.d), and the mean for the two (BS), and also the final position of the teeth. For a full definition of these terms, the reader is referred to the first article in this series.12

The statistical evaluation of the material was performed by testing the mean differences with Student's two-sample t test and also the one-way analysis of variance on the combined groups.

RESULTS

Between the "light" and "heavy" exposure groups (Table I), there were no significant differences in the values obtained for the plaque index, gingival index, and pocket depth for the tooth and the adjacent area or
Table II. Comparison between the variables in light and heavy movement

<table>
<thead>
<tr>
<th></th>
<th>Mean light</th>
<th>SD</th>
<th>Mean heavy</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 13)</td>
<td></td>
<td>(N = 10)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P11.c</td>
<td>1.55</td>
<td>0.67</td>
<td>1.85</td>
<td>0.85</td>
<td>0.89</td>
</tr>
<tr>
<td>P11.a</td>
<td>1.34</td>
<td>0.59</td>
<td>1.68</td>
<td>0.75</td>
<td>1.20</td>
</tr>
<tr>
<td>GI.c</td>
<td>1.09</td>
<td>0.68</td>
<td>1.30</td>
<td>0.64</td>
<td>0.74</td>
</tr>
<tr>
<td>GI.a</td>
<td>1.06</td>
<td>0.65</td>
<td>1.00</td>
<td>0.41</td>
<td>0.25</td>
</tr>
<tr>
<td>PD.c</td>
<td>2.33</td>
<td>0.73</td>
<td>2.76</td>
<td>0.62</td>
<td>1.52</td>
</tr>
<tr>
<td>PD.a</td>
<td>2.41</td>
<td>0.55</td>
<td>2.53</td>
<td>0.43</td>
<td>0.60</td>
</tr>
<tr>
<td>BS.m</td>
<td>91.38</td>
<td>4.99</td>
<td>88.80</td>
<td>1.38</td>
<td>1.32</td>
</tr>
<tr>
<td>BS.d</td>
<td>91.46</td>
<td>4.41</td>
<td>85.60</td>
<td>6.25</td>
<td>2.51*</td>
</tr>
<tr>
<td>BS.t</td>
<td>91.38</td>
<td>4.31</td>
<td>87.20</td>
<td>4.87</td>
<td>2.15*</td>
</tr>
<tr>
<td>Att.c</td>
<td>4.69</td>
<td>1.75</td>
<td>4.20</td>
<td>1.93</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Key to symbols:
P11 = Plaque index.
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PD = Pocket depth.
c = Relating to the canine.
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BS = Percentage bone support.
m = Mesial side.
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t = Total.
Att.c = Attached gingiva on the canine.
*p < 0.01.

Table III. Bone support related to exposure/movement combinations

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
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<th>Mean</th>
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<tbody>
<tr>
<td></td>
<td>BS.m</td>
<td></td>
<td>BS.d</td>
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<td>BS.t</td>
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</tr>
<tr>
<td>X, M (N = 5)</td>
<td>94.8</td>
<td>3.19</td>
<td>94.2</td>
<td>2.28</td>
<td>94.5</td>
<td>0.86</td>
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<td>X, M (N = 5)</td>
<td>89.2</td>
<td>3.11</td>
<td>87.0</td>
<td>5.00</td>
<td>88.1</td>
<td>3.34</td>
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<td>X, M (N = 5)</td>
<td>86.0</td>
<td>1.73</td>
<td>87.6</td>
<td>2.88</td>
<td>86.7</td>
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<td>X, M (N = 5)</td>
<td>88.4</td>
<td>5.72</td>
<td>84.2</td>
<td>7.62</td>
<td>86.3</td>
<td>6.34</td>
</tr>
<tr>
<td></td>
<td>p &lt; 0.02</td>
<td></td>
<td>p &lt; 0.05</td>
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<tr>
<td>X, M/X, M</td>
<td></td>
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<td>X, M/X, M</td>
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</table>

Key to symbols:
X = Light exposure.
M = Light movement.
Xh = Heavy exposure.
Mh = Heavy movement.

for the attached gingiva. For the bone support values, however, there were significant differences. The mean for "heavy" exposure for the total was 86.5% and the mean for "light" exposure was 91.9% (p < 0.01). The mesial and distal scores were almost identical.

There also were no significant differences between the groups that were categorized for "heavy" and "light" movement (Table II) in relation to the plaque index, gingival index, and pocket depth, for the individual teeth, and for the immediate areas, as well as to the attached gingiva. For the distal bone support and for the total bone support, statistically significant bone loss was greater for the "heavy" movements (87.2% for total) than for the "light" movements (91.4% for total) (p < 0.05).

When these groups were combined and redistributed in all their possible combinations, that is, light exposure—light movement (Xl, Ml), heavy exposure—light movement (Xh, Ml), light exposure—heavy movement (Xl, Mh), and heavy exposure—heavy
movement \((X_h M_h)\), no changes within the groups were noted in regard to plaque index, gingival index, and pocket depth for the tooth and the adjacent areas. Between the light exposure—light movement \((X_l M_l)\) group and the heavy exposure—light movement \((X_h M_l)\) group, there was found to be a significant difference in the attached gingiva \((6.2 \text{ mm and } 3.0 \text{ mm, respectively})\) \((p < 0.05)\).

Table III details the bone support as a function of the different combinations of type of exposure and movement. From this table, it can be seen that a significant difference is to be found in each of the categories of measured bone support, and the last line of this table shows between which combinations these differences exist.

When the 10 cases in which ideal alignment was found were compared to the 13 in which minor rotations and/or spacing were noted, no significant differences were detected in relation to plaque index, gingival index, and pocket depth for the canines themselves and for their immediate areas, or in the bone support or attached gingiva.

**DISCUSSION**

Many methods have been recommended for the surgical exposure of unerupted canines over the years, too many to warrant description here. Among the more widely accepted is that in which a flap is raised, and bone is removed widely enough to gain access to at least the widest diameter of the crown of the tooth and removal of the dental follicle down to the CEJ.\(^2\)

In the study by Wisth and his colleagues,\(^6\) comparison was made of cases in which only the soft-tissue management of the two groups differed at the time of surgical exposure. In the present study, the groups were differentiated according to the degree of bone removal.

The results of this study demonstrate that when the exposure factor is isolated from other treatment factors, there is a clear distinction between the more damaging effects of heavy exposure and a light exposure tech-
nique in relation to loss of bone support. This difference is more striking within the treatment group (5.4%) than was found in the whole treatment group, when compared with the control side (3.7%) in the first article of this series.

If the aim of a more radical surgical procedure is to improve the chances of spontaneous eruption or to encourage the canine to erupt more quickly, the price must be considered too high when judged in terms of loss of bone support that will inevitably result from the surgical insult. It would appear, too, that the deliberate wedging of heat-softened gutta-percha or other forms of pack into the follicular space or the use of a lasso wire (snare) around the neck of the tooth is likely to further undermine the bone support, since all these agents occupy space and traumatize the area of the CEJ.

Contrary to the circumstances surrounding the choice to expose modestly or liberally, the demands of orthodontic tooth movement required to bring the tooth into its place dictate that, in order to upright or torque a root to its desired axial inclination, the components we have defined as “heavy” need to be employed. Thus, when root movement is needed, “heavy” mechanics must be employed, but the operator should be aware that a degree of bone support will be lost.

Close scrutiny of the results of the analysis of bone support when both variables are examined together, by producing results that are close to the aggregated individual scores, confirms that each is a potent factor in determining the final level of bone support. Thus, it will be appreciated from Fig. 1 that the level of bone support (total) in those cases in which both the surgical exposure was “light” and the movement was “light” (X, M,) was comparable to that seen in the controls of our first study,12 which were unaffected and untreated canines of the opposite side. Whether the surgery was “heavy” and the movement “light” (X, M), or the surgery “light” and the movement “heavy” (X, M), the loss of bone support was considerable but comparable in the two cases (88.1% and 86.7%, respectively). When both surgical exposure and orthodontic movement were classed as “heavy” (X, M), the level of total bone support dropped to 86.3%, a net loss of 8.2%.

It will be seen, too, that the graph shows how a different behavior of the mesial and distal readings produces a “low” of 84.2% on the mesial side, following more radical surgery and root movement (X, M), a score which confirms the results of other studies14,15 which point out that more bone is lost on the mesial side.

If one compares the light exposure—heavy movement (X, M) to the light exposure—light movement (X, M), it will be noted that the bone level is reduced by 6.4% to 88.1%. In this case, the exposure was the same and the movement was variable. Now, taking the heavy exposure—light movement (X, M) and comparing it with the light exposure—light movement (X, M), the variable factor here is the exposure, which reduces the bone level by 7.8%, to 86.7%. This indicates that the surgical exposure is the more damaging of the two factors.

Furthermore, the difference in the level of bone between the heavy exposure—light movement (X, M) and the heavy exposure—heavy movement (X, M) is only 0.4%, which confirms that, once a more radical surgical procedure is performed, the type of movement involved will have little effect.

We considered it necessary to check whether the individual malposition of the teeth observed in some of our cases had an effect on periodontal health. From the results obtained, we have no reason to assume that any such effect exists in relation to mild malposition and thus does not interfere with our other variables. This confirms the results of earlier work.

CONCLUSIONS

In summary, we conclude that the most serious damage that occurs in the treatment of a palatally impacted canine is the result of surgical intervention that exposes the buried tooth to beyond its cementoenamel junction and will express itself in the form of loss of bone support. Whether more extensive surgery encourages teeth to erupt where a conservative approach may not or whether the speed of eruption may be increased has never been demonstrated to our knowledge. However, given the advances in the field of mechanotherapy that are available to the orthodontist today, it is considered that overzealous surgical procedures no longer have a place in the treatment of these teeth.

We wish to acknowledge the help given us by Dr. Gabriel Engel, in providing several of the cases studied and by Ms. Bella Pevsner for her assistance in the programming and analysis of the statistical data.

REFERENCES


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