Treatment of gummy smile with maxillary anterior teeth intrusion using miniscrews

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AIM: the objective of this study was to evaluate the usability of mini-screw, as an anchor unit (unites), in treatment of gummy smile associated with deep over bite. SUBJECTS AND METHODS: the sample was made up of 15 adult patients (2 males and 13 females) who were suffering from gummy smile (more than 2mm of gum appears above maxillary central incisors on smiling). Pretreatment and post-intrusion gingival smile line (GSL), which is the distance between cervical gingival margins of maxillary central incisors and the lower border of upper lip during smiling, was measured in millimeters using digital caliper. Four miniscrews were used for each patient, two anteriorly (between lateral incisors and canines) and two posteriorly (between 2nd premolars and 1st molars). Anterior miniscrews were used to intrude upper anterior teeth, while posterior miniscrews were used for retraction, without any load placed on posterior teeth. Pretreatment and post intrusion lateral cephalometric radiographic measurements were compared. Cone beam computed tomography CBCT was used to determine the proper positions of miniscrew, measure the amount of root resorption in maxillary incisors and to qualitatively evaluate the response to the treatment. RESULTS: there were statistically and clinical significant reduction in GSL and overbite. Cephalometric radiographic analyses have shown that correction of gummy smile and deep overbite were obtained mainly from bodily intrusion of upper front teeth without any significant extrusion of posterior teeth. Qualitative and quantitative CBCT findings showed that upper anterior teeth were purely intruded without flaring. CONCLUSION: the maxillary incisors could be intruded effectively using miniscrews without either changing the vertical positions of upper or lower posterior teeth, or proclination of upper incisors. The amount of root resorption, though it was statically significant, but it was within the range that would not compromise the vitality or stability of maxillary incisors.

Introduction

Excessive gingival display during full smile is unpleasant facial expression, which draws considerable interest among orthodontic society. It is usually referred as gummy smile. Gummy smile can be defined as: a full smile with 2 mm or more of maxillary gingival exposure (Peck et al., 1992; Zachrisson, 2005). Although, the main demand of laypeople is to have perfectly straightened white teeth, they have become more interested in having “Hollywood smile” in which a full set of well-aligned white teeth that follow the arc of the lower lip, with minimal gingival show (Van de Geld et al., 2011).

Because gummy smile is frequently associated with deep overbite, intrusion of upper anterior teeth is one of the main strategies used for its orthodontic treatment (Zachrisson, 1998). It should be fully respected that treatment of overbite per se depends largely on its etiology and the objectives of treatment. Deep overbite associated with excessive vertical maxillary incisors display, which is estimated by measuring Incision-Stomion distance (In-Sto), can be treated with intrusion of upper anterior teeth (Shroff et al., 1997; Zachrisson, 2005).

For treatment of gummy smile along with deep overbite, in cases of increased facial height, absolute intrusion of the maxillary incisors is required, rather than extrusion of posterior teeth (Bae et al., 2002; Al-Buraiki, 2005; Choi et al., 2010). In essence, absolute intrusion implies neither extrusion of posterior teeth nor flaring of upper incisors (Shroff et al., 1997; Nanda et al., 1998; Carano et al., 2005). To obtain pure incisors intrusion without flaring, the intrusive force must be applied in a way that it goes through the long axis of the incisor (Marcotte 1990; Nanda, Kuhlberg, 2005).

Traditionally, it has been established that intrusion of incisors using conventional orthodontic appliances has many obstacles: mainly the lacking of anchorage control, which leads to extrusion of maxillary
posterior teeth. This extrusion can compromise the facial height, especially in case of grown up patient with poor facial growth trend, where no growth can compensate for increased facial height (Marcotte 1990; Ohnishi et al., 2005; Nanda, Kuhlberg, 2005). Several remedies (appliances and techniques) have been recommended to control the vertical reactive movement of posterior teeth while intruding anterior teeth. Examples of those remedies are: high-pull headgear, J-hooks headgear, tips back in the arch wire, trans-palatal arch (TPA), segmented arches with basal intrusion arch, and CTA® arch wire. Unfortunately, they are either complicated or rely on excellent patient's cooperation, which is highly unreliable (Shroff et al., 1997; Nanda et al., 1998 Foley et al., 2003).

Since immediately loaded mini-implants are relatively new device that has been introduced into orthodontics since 1990s (Kanomi, 1997; Costa et al., 1998; Kyung et al., 2003; Luzi Cesare et al., 2009) it seems that there is a need for enrichment of literature with prospective clinical trials studies that aimed to evaluate mini-screws' usage in terms of effectiveness, ease of use, side effects and limitations. Therefore this study was done to assess the usability of temporary anchorage devices (TADs), as anchor units, in treatment of gummy smile.

**Subjects and Methods:**

The study protocols were approved by the Research Ethics and Quality Control committee, Faculty of Dentistry, Suez Canal University. Initially there was a random selection of gummy smile cases from outpatient clinic of orthodontic department, Faculty of Dentistry, Suez Canal University. The selected cases were subjected to inclusive and exclusive criteria (Table 1). Fifteen subjects, 2 men and 13 women, comprised the sample of this study. The average age was 22.5± 2.5 years. Patients who were willing to be included in this study were asked to provide signed informed consent in advance before commencing the treatment.

Lateral cephalometric radiographs and cast models were used for the pretreatment analysis according to Egyptian norms.

**Table 1:** Criteria according which sample cases were selected or rejected for the study.

<table>
<thead>
<tr>
<th>Inclusive criteria</th>
<th>Exclusive criteria</th>
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<tbody>
<tr>
<td>• Adult patient</td>
<td>• History of orthodontic treatment, occlusal adjustment or trauma</td>
</tr>
<tr>
<td>• Gummy smile: 2 mm or more of maxillary anterior gingiva show on full smile</td>
<td>• Chronic illness</td>
</tr>
<tr>
<td>• Deep over bite</td>
<td>• More than 3mm incisostomium distance</td>
</tr>
<tr>
<td>• Good oral hygiene</td>
<td>• Congenital anomalies like malformed, Missing or un-erupted front teeth</td>
</tr>
<tr>
<td>• No TMD symptoms</td>
<td>• Class III malocclusion</td>
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</table>

**Clinical measurements:** Measuring the gingival smile line (GSL) in mm. **GSL is the distance between the gingival margin of upper central incisors, and the lower marginal line of upper lip on full smile.** Each patient was asked to smile; the distance between the gingival margin of upper central incisors and the lower marginal line of upper lip was measured using an orthodontic digital caliper (Fig.1). The reading was taken three times, and the mean value was considered and written down in the patient’s diagnosis sheet. Vertical overlapping of upper incisors over lower incisors was another clinical variable which was measured to estimate: the amount of deep overbite, and the amount of intrusion that can be done without
compromising the vertical relation between upper and lower incisors, and without creating a cant in occlusal plane.

Radiographic examinations and analysis:
Pretreatment orthopantomograph (OPG) were taken for ordinary, and essential, orthodontic evaluation of the situation of the dentoavleolar apparatus and basal bone.

Standardized Lateral Cephalometric Radiographic Analyses:
Pre-operative cephalometric analyses were done using Onyx Ceph® software. The following variables were measured:
- Incision to stomion in millimeters (In-Sto)
- Incision to palatal plane in millimeters (U1-PP)
- Incisal apex to palatal plane in millimeters (U1apex-PP)
- Upper molar to palatal plane millimeters (U6-PP)
- Lower molar to mandibular plane in millimeters (L6-MP)
- Lower facial height to total facial height ratio (LFH/TFH)
- Upper incisors to FH (U1-FH) angle.

Procedures:
- After examination, investigations, and the pre-orthodontic treatment preparations (e.g. oral prophylaxis), bonding of the upper and lower arch was done. Roth system .022® was used in all cases.

- Once leveling, alignment and de-rotation were finished, stainless steel archwire (0.019’x0.025’) was placed to apply intrusive force; two J-hooks were soldered in the area between upper lateral incisors and upper canines bilaterally, and two crimpable hooks fixed just distal to upper canines. Two anterior Titanium alloy (Ti-6Al-4 V) mini screws, 6 mm length (AbsoAnchor®; SH1312-6, 1.2 mm tip diameter, 1.3 mm neck diameter) were inserted between incisors and upper canines (Fig.2).

- Posterior mini-screws, 8 mm length (AbsoAnchor®; SH1614-8, 1.4 mm tip diameter, 1.6 mm neck diameter) were inserted between maxillary first molars and maxillary second premolars (Fig.2).

Statistical analysis:
Wilcoxon signed rank statistical analysis test used for analyzing raw data. The raw data were tabulated, and then they were applied into SPSS® software for statistical analysis.

Intra-examiner reliability:
Since the gingival Smile Line (GSL) of all members of the sample was measured with one examiner. To evaluate the intra-examiner reproducibility, six randomly selected patients were re-measured by the same examiner after 7-10 days. There was no significant difference in measurements at 5% level of confidence between the two time-points.
Results:

**Gingival smile line (GSL):**

All cases of the study showed improvement in the vertical show of smile. Pretreatment mean value of the gingival smile line was 5.966mm (SD ± 1.274), whereas the mean value of post-intrusion gingival smile line was 1.566 mm (SD ± 1.1). The mean amount of reduction in gingival smile line (GSL) was 4.4 mm (Table 3); this amount of reduction was achieved in mean time of 13.133 months from the time of the first archwire placement. There was statistically significant difference between the values of GSL before treatment and after intrusion at the P < 0.05 level (Table 2).

**Table 2:** Descriptive statistics and significance of difference between pretreatment and post-intrusion clinical variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Normal mean</th>
<th>SD ±</th>
<th>Pretreatment mean</th>
<th>SD ±</th>
<th>Post-intrusion mean</th>
<th>SD ±</th>
<th>Z</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSL(mm)</td>
<td>15</td>
<td>1</td>
<td></td>
<td>5.966</td>
<td>1.27</td>
<td>1.566</td>
<td>1.1</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>OB %</td>
<td>15</td>
<td>30</td>
<td>5</td>
<td>75.333</td>
<td>15.29</td>
<td>30.4</td>
<td>1.12</td>
<td>-3.41</td>
<td>*</td>
</tr>
</tbody>
</table>

GSL: Gingival smile line  
OB: Overbite  
Z: the calculated value of Wilcoxon singed rank test  
*Significant P < 0.05

**Overbite:**

A noticeable reduction of deep overbite had been achieved. The mean reduction in the percentage of vertical overlapping overbite was 44.933%. The mean percentage of pretreatment overbite of the sample was 75.333% (SD ± 1. 52 %) and it became about 30.4% (SD ± 1.1 %) after intrusion of upper incisors; this reduction was statistically significant at the P > 0.05 level (Table 2).

**Radiographic variables:**

At P > 0.05 level of confidence, it was found that there were significant changes in the following variables: U1-PP, U1apex-PP and Ins-Sto in mm. On the other hand, no significant changes were detected in the following variables: U6-PP, L6-PP in mm and U1-FH angle (Table 3).

**Table 3:** Descriptive statistics and significance of difference between pretreatment and post-intrusion radiographical variables:

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Normal mean</th>
<th>SD ±</th>
<th>Pretreatment mean</th>
<th>SD ±</th>
<th>Post-intrusion mean</th>
<th>SD ±</th>
<th>Z-value</th>
<th>Sig</th>
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Table:

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>2</th>
<th>3</th>
<th>6.6</th>
<th>1.44</th>
<th>2.67</th>
<th>1.2</th>
<th>0.001</th>
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<tbody>
<tr>
<td>In-Sto mm</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>38.1</td>
<td>2.7</td>
<td>33.77</td>
<td>2.6</td>
<td>-3.445*</td>
</tr>
<tr>
<td>U1-PP mm</td>
<td>15</td>
<td>31</td>
<td>3</td>
<td>14.3</td>
<td>2.6</td>
<td>10.2</td>
<td>2.4</td>
<td>-3.39*</td>
</tr>
<tr>
<td>U1-FH°</td>
<td>15</td>
<td>112</td>
<td>6</td>
<td>121.6</td>
<td>9.8</td>
<td>116.87</td>
<td>7</td>
<td>-1.79 NS</td>
</tr>
<tr>
<td>U6-PP mm</td>
<td>15</td>
<td>25</td>
<td>3</td>
<td>30.23</td>
<td>4.187</td>
<td>30.267</td>
<td>4.2</td>
<td>-0.141 NS</td>
</tr>
<tr>
<td>L6-MP</td>
<td>15</td>
<td>33</td>
<td>3</td>
<td>37.167</td>
<td>4.526</td>
<td>36.73</td>
<td>5.75</td>
<td>-1.000 NS</td>
</tr>
<tr>
<td>LFH/TFH</td>
<td>15</td>
<td>60</td>
<td>3</td>
<td>62.36</td>
<td>3.96</td>
<td>62.36</td>
<td>3.89</td>
<td>0.00 NS</td>
</tr>
</tbody>
</table>

* U1-PP mm: Distance, in millimeters, between upper incisor and palatal plane on lateral cephalogram
  * U1-FH°: Angle between upper incisor long-axis and Frankfort horizontal plane
  * In-Sto mm: Vertical distance between upper incisal edge and upper Stomim in millimeters
  * U6-PP: distance, in millimeters, between the tip of mesial cusp of upper first molar and palatal plane
  * L6-MP: distance, in millimeters, between the tip of mesial cusp of lower first molar and mandibular plane
  * LFH/TFH: Lower facial height to total facial height ratio
  * n: sample size
  * Z: the calculated value of Wilcoxon signed rank test

Correlation relations:

A correlation coefficient test (r) was applied to investigate the association: (1) between reduction in amount of gingival show during posed smile, and the amount of overbite reduction (r = 0.70); (2) between the change in the vertical position of incisal edge and the incisal apex (relative to palatal plane) (r = 0.85).

Discussion:

Many treatment modalities have been put forward for treatment of gummy smile that vary according to the etiology of gummy smile. In case of gingival hyperplasia or lack of gingival recession evidenced by short clinical crown, gingivectomy can solve the problem (Kokich, 1996). Surgical maxillary impaction could be the treatment of choice for gummy smile due to maxillary vertical growth, (Uribe et al., 2008). However, surgical intervention can lead to several unwanted ramifications such as broadening nasal base and shortening upper lip (Waldrop, 2008; Proffit, Philips, 1988; Rosen, 1988).

This study indicates that intrusion of upper anterior teeth can be very effective treatment for gummy smile associated with deep overbite in cases with divergent faces. Almost the same suggestion was put forward by several studies (Eberhart et al., 1990; Xun et al., 2004; Ohnishi et al., 2005; Kim et al., 2006; Uribe et al., 2008). The pretreatment GSL of the sample ranged from 4 mm to 9 mm with mean value of 5.966 mm, after treatment it ranged from 0.00 mm to 5 mm with mean value of 1.566 mm.

Intruding upper anterior teeth up to the point where overbite is about 30% prevented esthetic problem that could be generated from reverse smile architecture and/or flaring of the smile arc “over intrusion” (Zachrisson, 2005). Reverse smile architecture can be caused by discrepancy between the posterior occlusal plane and the anterior incisal plane (Shroff et al., 1997; Xun et al., 2004). Uribe et al. (2008)
recommended not to intrude upper incisors more than 2 mm. Contrarily, Kanomi (1997); Ohnishi et al. (2005); Kim et al., (2006) have reported from 4 to 6mm of incisal intrusion using TADs, without esthetic complication. Shroff et al. (1997) and Zachrisson (2005) emphasized that Insion-Stomiom (In –Sto) distance should be respected when intrusion of upper incisor is adopted as treatment for deep overbite. They recommended avoiding reduction of (In-Sto) less than 3 mm, for sake of esthetic lip to incisors relationship, particularly in young adults.

This study has found that the range of incisors intrusion was 3mm to 5.5 mm, with mean value of about 4.4 mm. This amount of maxillary anterior teeth intrusion, in addition to correction of deep overbite, has been manifested clinically in form of reduction of gingival smile line (GSL) or correction of gummy smile. Additionally, a positive correlation between vertical over bite reduction and amount of reduction in the GSL was found. This finding is consistent with the fact that the ratio of incisal intrusion to reduction in vertical amount of gum show while smiling is 1:1 (Zachrisson, 2005; Nanda, Kuhlberg 2005) In other words, in addition to the effectiveness of intrusion of upper incisors in management of gummy smile, it is possible to predict the amount of reduction in gum show on smile, by knowing how much the incisor are going to be intruded.

The radiographic changes that were recorded after intrusion indicated that correction of gummy smile and deep overbite has occurred purely via intrusion of upper anterior teeth. This can be concluded from the reduction of In-Sto distance and U1-PP distance, and from stability of U1-FH angle. In addition, incision and root apex showed significant correlation in their superior movement (r = 0.839), indicating pure apical translation. Stability of vertical position of upper and lower molars in relation to palatal and mandibular planes respectively, excludes the possibility of reduction in vertical overlapping by anchorage loss in vertical dimension.

Though the intrusive force was applied in between upper lateral incisors and canines bilaterally, which, indeed, anterior to center of resistance of upper anterior teeth, flaring was prevented by the retrusive force (Sharoff et al., 1997, Nanda et al., 1998). The retraction was gained by using NiTi coil springs applied on crimpable hooks, which were crimped just distal to upper canines; posterior TADs were the anchor units. The retrusive force was applied at the same vertical height of the posterior miniscrews (using long multi-leveled crimpable hooks) in order to exclude any intrusive component while retraction. This manner of forces application (intrusive taking anchorage from anterior TADs; and retrusive taking anchorage from posterior miniscrews) led to pure intrusion of incisors with no flaring; and en-mass retraction of anterior teeth without any intrusion from the retracting coil spring. So both forces, intrusive and retrusive, were precisely and independently monitored (Upadhyay et al., 2008).

Since maxillary posterior teeth were not used as anchor units, neither for intrusion nor for retraction, almost no reactive force was resulted. Therefore no effect was detected on the facial height.

Reduction in the amount of gingival vertical show on smile was not up to the normal ranges in one case out of the 15 cases. This is due to the contribution of excessive maxillary vertical overgrowth in development of gummy smile, not only dentoalveolar over growth. The patient was reluctant to undergo surgery, and the results were satisfactory for her. The treatment of this case started with 9 mm GSL and finished it with 5mm GSL. This amount of reduction in gingival display while smiling was achieved mainly by upper anterior teeth intrusion. Park et al. (2001), Xun et al. (2004) and Kaku et al. (2012)
suggested that TADs are reasonable alternative for correction of gummy smile when surgery is unfeasible, such as when patient denies to be subjected to surgery.

Though the benefit of TADs in treatment of gummy smile is underestimated in literature (Carrillo et al., 2007; Feldmann, Bondmark 2006; kuroda et al., 2007; Padhyay et al., 2008; Paik et al., 2007), the use of TADs for upper incisors intrusion was intensively reported during the last decades (Ohnishi et al., 2005; Deguchi et al., 2008). The reports have indicated that effective maxillary incisors intrusion was achievable; with minimal side effects and without much patient cooperation, by using TADs as a stationary anchorage mean (Carrillo et al., 2007).

TADs provide better control of the intrusive forces that can reduce external apical root resorption (EARR), usually associated with intrusive orthodontic force (Costopoulos, Nanda, 1996; Ohmae M et al., 2001; Sameshima, Sinclair, 2001). Though dental implants and miniplates have also been successfully used for tooth intrusion (Southard TE et al., 1995; Erverdi et al., 2004; Erverdi et al., 2006), TADs have several advantages over miniplates and dental implants: immediately loaded, suitability to be inserted in different and difficult sites in dentoalveolar process, easiness of placement and removal and less expensive for patients (Carrillo et al., 2007).

**Conclusion:**

Gummy smile, which is mainly due to maxillary dentoalveolar over growth, can be treated effectively with intrusion using anterior TADs, particularly in case of divergent face.

Anterior and posterior minscrews are effective mean for an absolute anchorage in treatment of deep over bite and increased overjet.

When upper anterior teeth are retracted and intruded at the same time, accurate mount, and precise point of application of intrusive and retrusive orthodontic forces are crucial factors for pure intrusion and bodily translation of upper anterior teeth, without proclination.

**References:**


