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TEMPORARY ANCHORAGE DEVICES AND GUMMY SMILE

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ABSTRACT:

Aim was to evaluate the usability of mini-screw (Temporary Anchorage Devices TADs), as an anchor unit (units), in the treatment of gummy smile associated with deep over-bite. The sample was made up of 15 adult gummy smile patients (2males and 13 females).

Materials and Methods All patients suffered from increased anterior facial height. Pre-treatment and post-intrusion gingival smile line (GSL), which is the distance between cervical gingival margins of maxillary central incisors and the lower border of the upper lip during smiling, was measured in millimetres using a digital calliper. Four TADs were used for each patient: two anterior TADs that were inserted between the roots of lateral incisors and canines; and the other two TADs were used as anchor units for the intrusion of upper anterior teeth, while posterior TADs were used for en-mass retraction. Pre-treatment and post intrusion lateral cephalometric radiographic measurements were taken for statistical inferences. Statistical analyses were carried out using Wilcoxon signed rank test. Statistical analyses revealed significant reduction in GSL and overbite.

Results Radiographically, there were significant changes in the vertical and antro-posterior positions of upper anterior teeth, but no significant changes have been noticed in the vertical position of upper or lower posterior teeth.

Conclusions The findings of the present study indicate that gummy smile which is mainly due to maxillary dentoalveolar overgrowth can be treated effectively with intrusion using anterior TADs, particularly in case of divergent face. The findings also indicate that anterior and posterior TAD scan provide absolute anchorage for treatment of deep overbite, and increased overjet.

الملخص العربى

أجهزة المرسى المؤقتة و الابتسامة اللثوية

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الهدف: من الدراسة هو تقبيم إمكانية استخدام المسمار المصغر (أجهزة المرسى المؤقتةTADs)، باعتبارها وحدة مرساة ، في علاج الابتسامة اللثوية (gummy smile) المرتبطة بعضة عميقة . تكونت عينة الدراسة من 15 مريضا بالغا ذو ابتسامة لثوية (2 ذكور و 13 إناث).

المواد والطرق: عانى كل المرضى من زيادة ارتفاع الوجه الأمامي. وقد تم قياس ما قبل المعالجة وبعد اقتحام خط ابتسامة اللثة (GSL)، والتي هي المسافة بين هوامش عنق اللثة من القواطع الوسطى العلوية، والحد السفلي من الشفة العليا خلال الابتسامة بالملليمتر باستخدام فرجار قياس رقمي. استخدمت أربعة TADs لكل مريض: اثنان TADsأمامية التي تم إدراجها بين جذور القواطع الجانبية والأنياب. وأدرجت الأخريين الجزء الخلفي، بين جذور الضواحك 2 والأضراس 1. اتخذت قبل العلاج وبعد الاقتحام الوحشي القياسات الإشعاعية للرأس للاستدلالات الإحصائية. وأجريت التحليلات الإحصائية من استخدام اختبار يلكوكسن.

النتائج: كشفت التحليلات الإحصائية انخفاض كبير في GSL وتراكب العضة. إشعاعيا، كانت هناك تغييرات كبيرة في مواقف الرأسي والامامية-الخلفية للأسنان الأمامية العلوية، ولكن لم يلاحظ أي تغييرات كبيرة في الوضع الرأسي للالأسنان الخلفية العلوية أو السفلية.

الاستنتاجات: نتائج هذه الدراسة تشير إلى أن الابتسامة اللثوي الذي يرجع أساسا إلى زيادة نمو الفك العلوي وأسناخ يمكن علاجها بفعالية مع اقتحام باستخدام TADs أمامية، ولا سيما في حالة مواجهة متباينة. تشير النتائج أيضا إلى أن TAD الأمامي والخلفي المسح يوفر مرسى مطلق لعلاج تراكب العضة العميقة، وزيادة overjet.

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INTRODUCTION

Excessive gingival display during the full smile is an 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 (Pecket al., 1992; Zachrisson, 2005). Although, the main demand of lavpeople 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 the minimal gingival show (Van de Geldet al., 2011).Because a gummy smile is frequently associated with deep overbite, intrusion of upper anterior teeth is one of the main strategies used in 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 incisor display, which is estimated by measuring Incision-Stomiom distance (In-Sto), can be treated with the intrusion of upper anterior teeth (Shroffet al., 1997; Zachrisson, 2005). For treatment of gummy smile along with deep overbite, in cases of increased facial height, the absolute intrusion of the maxillary incisors is required, rather than extrusion of posterior teeth (Baeet al., 2002; Al-Buraiki, 2005; Choiet al., 2010). In essence, absolute intrusion implies neither extrusion of posterior teeth nor flaring of upper incisors (Shroffet al., 1997; Nanda et al., 1998; Caranoet 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 the 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 that grown up patient with poor facial growth trend, where no growth can compensate for increased facial height (Marcotte 1990;Ohnishiet 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, and tips back in the arch wire, transpalatal 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 (Shroffet 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: LuziCesare et al., 2009) it seems that there is a need for the enrichment of literature with prospective clinical trial 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 the treatment of a gummy smile.

MATERIALS 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 the 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, 2men and 13 women, comprised the sample of this study. The average age was22. 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 (Aboul-Azm et al., 1984).

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

Inclusion criteria	Exclusion criteria				
Adult patient	History of orthodontic				
Gummy smiles: 2 mm or	treatment, occlusal adjustment				
more of the maxillary anterior	or trauma				
gingiva show on full smile	Chronic illness				
Deep overbite	More than 3mm incision-				
 Good oral hygiene 	stomium distance				
 No TMD symptoms 	Congenital anomalies like				
	malformed, Missing or un-				
	erupted front teeth				
	Class III malocclusion				

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 the 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 the upper lip was measured using an orthodontic digital caliper (Fig.1).



Fig. 1 The measurement of gingival smile line GSL.

The reading was taken three times, and the mean value was considered and written down on 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 dentoalveolar apparatus and basal bone.

Standardized Lateral Cephalometric Radiographic Analyses:

Pre-operative cephalometric analyses were done using Onyx Ceph^{®*}software. The following variables were measured:1)Incision to stomion in millimeters (In-Sto),2)Incision to palatal plane in millimeters (U1-PP),3)Incisal apex to palatal plane in millimeters (U1apex-PP), 4)Upper molar to palatal plane millimeters (U6-PP), 5) Lower molar to mandibular plane in millimeters (L6-MP), 6) Lower facial height to total facial height ratio (LFH/TFH), 7)Upper incisors to FH (U1-FH) angle.

Procedures:

After examination, investigations, and the preorthodontic 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 finished, stainless steel archwire were (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 has hooked fixed just distal to upper canines. Two anterior Titanium alloy (Ti-6A1-4 V) mini screws, 6mm length (AbsoAnchor®; SH1312-6, 1.2mm tip diameter, 1.3mm neck diameter)were inserted between incisors and upper canines (Fig.2).Posterior mini-screws, 8mm length (AbsoAnchor[®]; SH1614-8, 1.4mm tip diameter, 1.6mm neck diameter) were inserted between maxillary first molars and maxillary second premolars (Fig.2).



Fig. 2: Anterior and posterior mini-screws

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 \pm 1.274), whereas the mean value of post-intrusion gingival smile line was 1.566 mm (SD \pm 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 Table 2: Descriptive statistics and significance of different

difference between the values of GSL before treatment and after intrusion at the P < 0.05 level (Table 2).

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 $\pm 1.1\%$) after the 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 2: Descriptive statistics and significance of difference l	between pretreatment and post-intrusion clinical variables
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Variable	n	Normal		Pretreatment		Post-intrusion		Ζ	Sig.
		mean	SD	mean	SD	mean	SD		
GSL(mm)	15	1.5	1	5.96	1.27	1.56	1.11	0.000	*
OB %	15	30	5	75.33	15.29	30.41	1.12	-3.410	*

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

Correlation relations:

Correlation coefficient test(r) was applied to investigate the association :(1) between reduction in the amount of the gingival show during posed smile, and the amount of over bite 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).

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

Variable	n	Normal		Pretreatment		Post-intrusion			
		mean	SD ±	mean	SD ±	mean	SD ±	Z-value	Sig
In-Sto mm	15	2	2	6.6	1.44	2.67	1.20	0.001	*
U1-PP mm	15	30.5	2.5	38.12	2.71	33.77	2.60	-3.445	*
U1apex-PPmm	15	-	-	14.30	2.62	10.22	2.40	-3.391	*
U1-FH ^O	15	112	6.5	121.60	9.81	116.87	7.00	-1.792	NS
U6-PP mm	15	25	3	30.23	4.18	30.26	4.20	-0.141	NS
L6-MPmm	15	33.5	3	37.16	4.52	36.73	5.75	-1.000	NS
LFH/TFH%	15	60	3	62.36	3.96	62.36	3.89	0.000	NS

DISCUSSION:

Many treatment modalities have been put forward for treatment of gummy smile that vary according to the etiology of a 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 Citation:Libyan Dent 2015, 5: 20918721 -http://dx.doi.org/10.5542/LDJ.v3i0.15115672 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 the nasal base and shortening upper lip (Waldrop, 2008; Proffit, Philips, 1988; Rosen, 1988). This study indicates that the intrusion of upper anterior teeth can be a 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 (Eberhartet 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 4mm to 9mm with a mean value of 5.966mm, after treatment, it ranged from 0.00mm to 5mm with a mean value of 1.566mm.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 flatting of the smile arc "over intrusion" (Zachrisson, 2005). Reverse smile architecture can be caused by the discrepancy between the posterior occlusal plane and the anterior incisal plane (Shroffet al., 1997; Xunet al., 2004). Uribe et al. (2008) recommended not to intrude upper incisors more than 2mm. Contrarily, Kanomi (1997); Ohnishi et al.(2005); Kim et al., (2006) have been 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 the intrusion of upper incisor is adopted as treatment for deep overbite. They recommended avoiding the reduction of (In-Sto) less than 3mm, for the sake of the esthetic lip of incisor relationship, particularly in young adults. This study has found that the range of incisors intrusion was 3mm to 5.5mm, with a mean value of about 4.4mm. This amount of maxillary anterior teeth intrusion, in addition to correction of deep overbite, has been manifested clinically in the form of reduction of gingival smile line (GSL) or correction of a gummy smile. Additionally, a positive correlation between vertical over bite reduction and the amount of reduction in the GSLwas found. This finding is consistent with the factthat the ratio of incisal intrusion to reduction in the vertical amount of gum show while smiling is 1:1 (Zachrisson, 2005; Nanda, Kuhlberg2005)In other words, in addition to the effectiveness of intrusion of upper incisors in the management of a gummy smile, it is possible to predict the amount of reduction in gum show on smiling, by knowing how much the incisor is 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 the stability of U1-FH angle. In addition, incision and root apex showed significant correlation in their superior movement (r = 0.839), indicating the 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 of 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(Sharoffet al., 1997, Nandaet 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 minscrews) 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 (Upadhyayet 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. Parket al.(2001), Xunet al.(2004) and Kakuet al. (2012) suggested that TADs are reasonable alternative for correction of gummy smile when surgery is unfeasible, such aswhen 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; kurodaet al., 2007; Padhvayet 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; Deguchiet 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 (Carrilloet 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; Erverdiet al., 2004; Erverdiet al., 2006), TADs have several advantages over mini-plates and dental implants: immediately loaded, suitability to be inserted in different and difficult sites in dentaoalveolar process, easiness of placement and removal and less expensive for patients (Carrilloet 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 mini-screws 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.

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