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Corticision-enhanced intrusion of maxillary incisors using skeletal anchorage in adults with gummy smiles: A randomized controlled clinical trial

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Introduction*: The gummy smile caused by extruded maxillary incisors was successfully treated with their intrusion by miniscrews. In order to accelerate this treatment, a minimally invasive surgical technique called corticision was introduced. The aim of this clinical trial was to investigate the effect of corticision on the duration and rate of intrusion of maxillary incisors in patients with gummy smiles with deep bite.*
Methods: *Fourteen Egyptian adult patients (twelve females and two males) with gummy smile and deep bite were divided into two equal groups; corticision with intrusion group and intrusion without corticision group. The intrusion was done with two NiTi closed coil springs attached to the two miniscrews inserted between the roots of maxillary lateral incisors and canines and to the segmented wire from the two maxillary lateral incisors. The corticision technique was performed by a scalpel and mallet by making cortical incisions between the roots of the four maxillary incisors. The duration and rate of intrusion were evaluated, as well as, apical root resorption and periodontal condition of intruded teeth.*
Results: *There was no significant difference in the duration of intrusion between the corticision (4.1 months) and the control (4.5 months) groups. Also, there was no significant difference in the rate of intrsion between the corticision (0.68 mm/month) and the control (0.42 mm/month) groups. The periodontal condition of the intruded teeth was not changed after intrusion in both groups. Only irregular root contour was revealed after intrusion in both groups with insignificant difference between them.*
Conclusions: *The application of corticision during the intrusion of maxillary incisors, neither increased the rate of intrusion, nor decreased the duration of treatment. Most of the teeth in both intrusion groups manifested irregular root contour (score 1). Nearly all the cases showed a good periodontal codition after corticision.*

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One of the most successful and pleasing modalities of treatment, if the cause of the gummy smile is extruded maxillary incisors, is their intrusion using temporary anchorage devices.[1] This treatment gives best intrusion results with least amount of anchorage loss than other modalities for intrusion such as J-hook headgear and utility arch. [1 , 2] As the intrusive force should be minimal to avoid any dangerous effects in dental pulpal tissues, thus the treatment time is accordingly prolonged when treating such patients with gummy smile. Also, the intrusive force can increase the incidence of root resorption. [3]

Corticotomy is a surgical procedure that enhances the orthodontic tooth movement increasing its speed and decreasing incidence of root resorption.[4,5] As the corticotomy procedure is a flap procedure which is very invasive and annoying for patients, corticision, flapless corticotomy, is more acceptable and less invasive procedure.[6] To overcome the disadvantages of corticotomy techniques, [6] a minimally invasive, flapless procedure combining surgical cortical micro-incisions with selective tunneling that allows for bone or soft-tissue grafting could be used. Due to its precision, corticision creates precise osteotomies without the risk of osteonecrosis,[7] thus reducing surgical time and postoperative discomfort. It allows for rapid correction of severe malocclusions without the drawbacks of traumatic conventional corticotomy procedures. The gummy smile treatment by maxillary incisors' intrusion associated with corticision was not supported by enough evidence. No randomized controlled studies were found regarding this issue. [8] So the need of this study is essential, because it evaluated the rate of intrusion by miniscrews when combined with corticision in comparison with intrusion with miniscrews without corticision. The present study also evaluated the status of the periodontal tissue and root resorption of the intruded teeth in different treatment stages allowing for understanding the periodontal health of the intruded teeth.

I. Material And Methods

The sample of present study consisted of fourteen Egyptian adult patients (12 females and 2 males) with age ranged from 20 to 25 years divided into two equal groups. They were collected from Orthodontic Department of the Faculty of Dentistry, Cairo University. The inclusion criteria were: Patients with Class I or

Class II malocclusion with deep overbite (overbite above 3 mm). Patients with gummy smile, more than 3 mm of gingival tissue display on smiling (measured on patient`s posed smile clinically and on the photos taken).
A segmented leveling and alignment stage (T0) of the maxillary central and lateral incisors as the anterior segment, and two posterior segments; right and left from the maxillary canines to the first molars. A segmented 0.019" × 0.025" stainless steel wire from the right and left lateral maxillary incisors was applied and bent occlusally for easier coil spring attachment (figure 1). Then the following records taken; extra-oral frontal smile and close-up smile photos, lateral cephalometric radiograph, periodontal assessment and periapical radiographs for apical root resorption assessment.

Figure 1: *Intra-oral photograph showing the upper arch with completed segmented leveling reached 0.019" × 0.025" stainless steel wire, as the anterior segment from the maxillary lateral incisors with occlusal bends for easier coil engagement. Note that the lower arch stabilized after complete leveling and alignment with 0.016" × 0.022" stainless steel wire.*

Lateral cephalometric analysis was done by 13 different linear, angular and soft tissue measurements. The most important of them were; **CR-PP:** the linear measurement from the center of resistance of the upper maxillary central incisor to the palatal plane.[9, 5] Then the rate of intrusion was calculated using the following formula[10]:

$$\text{Rate of intrusion (mm\month)} = \frac{\text{Mean amount of intrusion achieved (mm)}}{\text{Mean treatment time recorded for intrusion (month)}}$$

CR-SN: The linear measurement of a line from the center resistance of maxillary central incisor perpendicular to the SN plane, [11] **Is-PP:** The linear measurement of a line from the incisal edge of maxillary incisor perpendicular to the palatal plane,[11] **OB:** Overbite: the vertical distance between the incisal edges of upper and lower central incisors perpendicular to the occlusal plan.[12] **OJ**: Overjet: the horizontal distance between the incisal edges of upper and lower central incisors parallel to the occlusal plan,[12] **U1\PP:** Angle formed between the maxillary central incisor long axis and palatal plane,[13] and **Is-St:** the vertical distance between the incisal edge of the maxillary incisor to the stomiom of the upper lip perpendicular to the occlusal plan..[12]

Periodontal assessment were done based on the following scoring codes [14] given to each tooth before and after intrusion according to their pocket depth, calculus and bleeding on probing and recorded on patient periodontal chart: **Score 0:** No pockets more than 3.5 mm, no calculus/overhangs and no bleeding on probing, **Score 1:** No pockets more than 3.5 mm, no calculus/overhangs but bleeding after probing, **Score 2:** No pockets more than 3.5 mm but supra- or subgingival calculus/overhangs, **Score 3:** Probing depth 3.5-5.5 mm, **Score 4:** Probing depth more than 5.5 mm.

Periapical radiographs were done in order to measure the degree of root resorption after intrusion. The periapical radiographs were scanned and digitized by the same scanner with the same settings. With Digora software, each digital radiograph calibrated before starting measurements. Then a score was given to each tooth according to its length and form [15] as follow: **Score 1:** Irregular root contour, **Score 2:** Root resorption apically, amounting to less than 2 mm. (Minor resorption), **Score 3:** Root resorption apically, from 2 mm to one third of the original root length (Severe resorption), **Score 4:** Root resorption exceeding one third of the original root length (Extreme resorption).

Corticision was done after leveling and alignment stage and insertion of the TADs (T1). According to ***Park,***[16] a surgical scalpel blade no.15 was inserted in the maxillary labial gingiva 5 mm apical to the interdental papilla between the roots of maxillary incisors and tapped by a mallet to 8 mm depth in the labial bone, then angulated 45 degrees apically and tapped to 12 mm depth and then removed by a swing motion. The maxillary

incisors then were grapped by the operator`s fingers and forcibly moved in buccal and palatal directions. Corticision was repeated every 3 weeks and the patients were instructed to strict oral hygiene measures. The force of intrusion applied by NiTi coil springs* was 40 gm per side, 20gm per tooth to the segmented wire. The coil was checked every 3 weeks and activated if needed. Intrusion stage (T2) continued until proper overbite was achieved. The measurements were clinically recorded every 3 weeks.

II. Results:

The mean duration of intrusion in the corticision group was 4.1 ± 1.061 months (123 ± 30.5 days) and in the control group was 4.54 ± 1.91 months (136.2 ± 57.3 days). The mean difference between the two groups was insignificant 0.442 ± 0.81 months (13.28 ± 24.55 days). The rate of intrusion in the corticision group was 0.687 ± 0.56 mm\month (0.022 ± 0.018 mm\day) and in the control group was 0.426 ± 0.155mm\month (0.014 ± 0.005 mm\day). The mean difference between the two groups was not significant (0.26 ± 0.22 mm\month, 0.008 ± 0.007 mm\day).

Table: *The independent samples t test for comparing the duration and the rate of intrusion between the two groups.*

Intrusion	Mean ± SD		P-value
	Intervention	Control	
Duration (months)	4.1 ± 1.061	4.54 ± 1.91	0.51
Duration (days)	123 ± 30.5	136.2 ± 57.3	0.62
Rate of intrusion (mm/month)	0.687 ± 0.56	0.426 ± 0.155	0.25
Rate of intrusion (mm/day)	0.022 ± 0.018	0.014 ± 0.005	0.27

SD= Standard Deviation.

The cephalometric analysis showed a significant reduction in the distance from CR to PP between pre and post intrusion was found within each group (corticision gp. = 2.76 ± 2.1 mm, control gp. = 1.3 ± 0.95 mm). However, there was no significant difference in the amount of intrusion between both groups (mean= 1.46 ± 0.87 mm). A significant movement of the center of resistance of maxillary incisors towards the SN plane was found in the corticision group (mean= 3.06 ± 3.43 mm), while in the control group there was no significant difference between the pre and post intrusion measurements (mean= 2.83 ± 3.89 mm). The difference between the two groups was not statistically significant (mean= 0.23 ± 1.96 mm). The change in the overjet after intrusion was not significant in each group (corticision group mean= 0.80 ± 1.99 mm, control group mean= 0.50 ± 1.16 mm) and when comparing the two groups (mean= 1.3 ± 0.87 mm). There was a significant labial flaring of the maxillary central incisors after intrusion in both groups (corticision gp. = 8.01 ± 6.58°, and control gp. = 5.37 ± 4.85°). However, when comparing the two groups, the difference was not significant (mean= 2.64 ± 3.09°).

The periodontal assessment showed that almost all teeth in the both groups had a high percentage of score 1. The overall difference between the pre and post intrusion periodontal status within each group was not significantly different.

The root resorption assessment showed that almost all teeth in both groups had a high percentage of score 1 (irregular root contour). The overall difference within each group between the pre and post root resorption was not significantly different.

III. Discussion:

Intrusion of maxillary incisors using temporary anchorage devices for gummy smile correction is the most successful treatment mechanics due to minimal anchorage loss compared to other modalities. Among the intrusion mechanics of the upper anterior teeth, the best results were achieved by segmented techniques with skeletal anchorage by miniscrews.[2, 3, 10, 11] Segmented techniques allow intrusion with more controlled vertical movement with constant force and less liability of root resorption.[12]

The aim of this study was to evaluate the effectiveness of the corticision technique (flapless corticotomy) in accelerating the maxillary incisors' intrusion in patients with deep bite and gummy smile. The effectiveness of corticision was studied in accelerating the intrusion of the four maxillary anterior teeth as one segment that to date was not studied before.

The study included two males and twelve females, as there was no variability in treatment outcome according to the sex differences.[17] Only adult subjects were selected in order to eliminate the growth component

* JISCOP® Ni-Ti coil springs, heavy 8 mm, 0.009"×0.036" (0.23mm × 0.9mm), eylet size: 1.5ϕ – 2.5ϕ.

and to ensure that all changes during the treatment period were attributed to therapeutic measurements alone.[14] The included patients had anterior gummy smile more than 3 mm diagnosed clinically by measuring the amount of gingival tissue appeared on posed smile of every patient by a ruler (measured from the lower border of the upper lip to the gingival margins of the upper incisors).[21] Also, the included patients had deep overbite more than 3 mm measured clinically by measuring the amount of lower incisors covered by the upper incisors.

The intrusion started after complete segmented leveling and alignment. This segmented technique of leveling allowed pure intrusion in the anterior segment alone without affecting the posterior teeth.[12] There was one patient excluded after leveling and alignment stage as the deep bite was improved by the leveling, and another patient was recruited.

The miniscrews in the current study were placed in the buccal cortical bone 8 mm apically and 5 mm distally to the roots of the maxillary lateral incisors, so that the intrusive force could be applied close to the CR of the four maxillary incisors. [10] The force of intrusion used in this study was 40 grams per side as the increase amount of force did not induce more intrusion nor decreased labial tipping, besides, the 40 grams of force did not produce deleterious effects to the pulpal tissue.[18]

The corticision technique was performed in the intervention group by five cortical incisions in the labial cortical plate between the roots of maxillary central, lateral incisors and canines in a flapless technique as described by ***Kim et al*** [19] and ***Park et al.*** [16] The depth of the alveolar penetration was ten to twelve millimeters with apical angulation of the scalpel in order to make a beneficial cancelous bone osteotomy, which was expected to generate more blood flow by enhancing new blood vessels and enhance trabecular bone remodeling.[16]

The center of resistance determined for the maxillary central incisor rather than for the anterior segment because of its ease of location and high reproducibility.[9] ***Weiland et al*** [11] used a midpoint of tooth length to determine the center of resistance and ***Kinzel et al*** [20] used a point 13 mm away from incisal edge. However, the method used in the current study considered the center of resistance based on the root length apical to the alveolar crest, as the bone level was an important factor that might affect the position of the center of resistance of any tooth.[10]

Total intrusion duration was 4.1 months in the corticision group which was not significantly different from the control group (4.54 months). These results were similar to the study by ***Polat et al*** [12] as they used the same technique in the same age group, but less than other studies by ***Deguchi et al*** [3] and ***Polat et al*** [23] may be due to these studies used different intrusion mechanics with different age groups. The rate of intrusion in the corticision group was 0.6 mm/month and 0.4 mm/month in the control group and the difference was not statistically significant. These results were concomitant with other studies by ***Aras et al,*** [31] ***Kumar et al,*** [32] ***Namarawy et al.*** [21] ***Mimura H.***[22] who found acceleration of mandibular molar protraction after partial corticision facilitating its movement. Thus, corticision had no benefit in increasing the rate of maxillary incisors' intrusion.

The degree of overbite reduction was 3.17 mm in the corticision group and 2.34 mm in the control group. The difference between the two groups was not statistically significant. Our results were in accordance to other studies by ***Deguchi et al*** [3] and ***Namarawy et al.*** [21] The amount of intrusion assessed using the linear measurement from the center of resistance of the maxillary central incisor to the palatal plane (CR-PP) was 2.76 ± 2.1 mm in corticision group and 1.3 ± 0.95 mm in the control group. The mean difference between the two groups was not significant. This result was concomitant to other studies by ***Aras et al,*** [24] ***Namarawy et al*** [21] and ***Polat et al.*** [23] The amount of intrusion did not show significant changes between groups because the included patients had almost the same overbite before intrusion, so the intrusion was done by the same amount in all patients.

The degree of labial tipping of maxillary central incisor showed a significant flaring of the incisors after intrusion in both groups, but when comparing the two groups the difference was insignificant (corticision group mean= 8.01 ± 6.58°, and control group mean= 5.37 ± 4.85°, mean difference between two groups = 2.64 ± 3.09°). These results were similar to studies by ***Aras et al,*** [24] and ***Steenburgen et al,*** [9] as they used the same technique with the same inclusion criteria, but different from other studies by ***Namarawy et al,*** [21] ***Falahi et al*** [25] and ***Polat et al*** [12] as they used the same intrusion mechanics but different inclusion criteria. ***Namarawy et al*** [21] and ***Polat et al*** [21] included younger age group, while ***Falahi et al*** [25] included younger age group and different miniscrews position.

IV. Conclusion:

Based on the results obtained from the present study the following conclusions could be drawn: The application of corticision during the intrusion of maxillary incisors, neither increased the rate of intrusion, nor decreased the duration of treatment. There was no significant difference between corticision and non-corticision intrusion groups regarding the labial tipping of maxillary incisors, where it was increased in both groups following intrusion. Most of the teeth in both intrusion groups manifested irregular root contour (score 1).

Nearly all the cases showed periodontal index of score 1, which was not statistically different between the two groups.

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