



Evaluation of Buccal Alveolar Bone after Orthodontic Treatment with Clear Aligner (cone beam study)

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KEYWORDS

Clear aligner,
Buccal alveolar bone,
Orthodontic, Periodontitis, Cone
beam computed tomogram,
Malocclusion.

ABSTRACT

Aim: To determine the effect of clear aligner on buccal bone after orthodontic treatment. **Subjects and Methods:** This study selected of 14 patients aged (of both sexes) have age from 15-25 years that showed minor to moderate malocclusion then divided into 2 groups: Aligner and Fixed groups both groups are prepared for orthodontic treatment and aligner sets and wires are changed in sequence. Patients are chosen from the clinic of Faculty of Dental medicine, Al-Azhar University, Assiut branch. The orthodontic clinic evaluated the individuals' eligibility based on inclusion and exclusion criteria. Each patient signed an informed consent form after learning about the operation. CBCT scans were used in this investigation. **Results:** both aligner and braces have nonsignificant effect on bone thickness. However, bone height shows significant difference between both groups. **Conclusion:** bone height reduction in aligner group is lower than in fixed, while there is no significant difference representing bone thickness.

INTRODUCTION

Alveolar bone is the most liable structure in the periodontium subjected to continual remodeling because of its high sensitivity to external mechanical stimuli.⁽¹⁾

The alveolar bone means the tissue that houses and supports the tooth sockets in the maxillary and mandibular jaws. An external cortical plate, The process is composed of an interior socket wall called the alveolar bone proper, which is compact bone, and a cancellous trabecular bone that lies between the two bony layers. when compared to the buccal portions, the palatal bone is typically thicker, the cribriform appearance of the alveolar bone provides a connection to the neurovascular systems, The crest of the osseous alveolar edge generally follows the contour of the cement enamel junction of teeth. The structure and morphology of the alveolar process are dependent on the tooth.⁽²⁾

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The thickness of alveolar crest vary from posterior to anterior, the mandibular posterior region had the thickest crestal bone, Then the anterior area of mandible ,Then anterior area of maxilla, and the posterior area of maxilla had the thinnest crestal bone.⁽³⁾

From coronal to apical, alveolar width increased, the central incisor had a much greater alveolar surface area than the lateral incisor. The assumption "Tooth movement is traced by bone" is the main orthodontic rule which states that the bone surrounding the alveolar socket remodels in proportion to orthodontic tooth movement.⁽⁴⁾

(Alveolar bone and root) resorption during orthodontic treatment have been found to be influenced by various factors, including age, the type of orthodontic appliance used, the direction in which teeth move, and the applied force and timing of the treatment.⁽⁵⁾

The anchor teeth and the tissues that support them may undergo unfavorable alterations, such as vestibular dental tipping, root resorption, a decrease in the thickness of the buccal bone, and marginal bone loss. Regarding this, More severe periodontal problems, such as gingival recessions, dehiscence, and/or fenestrations, are pertinent clinical concerns.^(6, 7)

The use of clear aligners to treat malocclusion has increased dramatically in recent years, and thanks to manufacturers' aggressive marketing campaigns, there has been a growing interest in these invisible orthodontics techniques, particularly among adult patients..⁽⁸⁾

Patients that have simple Class I malocclusions using clear aligners Smart Force features and attachments require 4.8 months longer treatment times than those using traditional braces.⁽⁹⁾

As the demand for clear aligner therapy grows, it's more important than ever for orthodontists to understand how they work, Clear aligners and classic fixed appliances both work in the same way in which putting pressure on the teeth Despite the fact that they are based on the same

concepts, there are numerous distinctions in therapy techniques. The ability to remove orthodontic aligners is a significant improvement. This necessitates patient compliance. Another important factor is the design of the appliance makes a difference. Aligners are made of polymer trays that wrap securely over your teeth and allow you to apply force. This distinction has a lot of benefits (for example, patient confidentiality). the limitation of this type of treatment (e.g., small amount of force applied every step) .^(10, 11)

Aesthetic considerations are the major role in patients' desire. Because they want to disappear their brackets, orthodontics has advanced in this area, As a result, aesthetic orthodontic methods (using asthetic brackets) and Aligners made of thermoplastic.⁽¹²⁾

The main advantages are the ability to remove these appliances, good hygiene, low pain sensation during treatment, and the virtual view for results using a computer software.⁽¹³⁾

PATIENTS AND METHODS

14 patients, with age from 15 to 25, were chosen from the the clinic of Al-Azhar University, Assiut branch's for this study. The orthodontic clinic evaluated the individuals' eligibility based on inclusion and exclusion criteria. Each patient signed an informed consent form after learning about the operation.

Clinical procedure

All patients were randomly selected for the two groups using research randomization. After evaluation the patient was informed with steps and details of the treatment plan and applied on consent form.

Clear aligner group

1. Clear aligner fabrication

For patients in the aligner group, an addition silicon impression was accurately copied to record the teeth and ridge accurately. The



addition silicone impression was sent to the lab with all details and data for aligner construction.

2. Preparation of patients

There are some preparations for the patient before receiving the aligner as following:

1. Acid etching for tooth which will have attachment
2. Bond application
3. Loading composite in the template tray for attachment building up
4. Set the tray intraorally and curing

3. Patient instructions:

Once the aligners have been fabricated, each patient receives their appliances with instruction protocol for wearing to every group. These patients were informed to change the appliance every 2 weeks to give their effect on tooth movement and take a new aligner set every visit.

Fixed braces group

For fixed group braces are bonded and wires are changed in sequence every 3week by NiTi round: 0.012, 0.014, 0.16, 0.018, Then 0.016*0.022 rectangular Ni Ti, 0.017*0.025 StSt.

As with aligner group teeth are etched, bonding, brackets are placed, curing and wire is placed.

Measurement Procedures

For every group, cone beam CT are recorded prior to treatment (T0) and after leveling and alignment (T1). Every CBCT file was entered into Mimics software with DICOM file format and the following measurements were assessed:

For every group, first incisor and canine and first molar in the right side (for standardization) were used for measuring this variable between two groups.

Table (1)

Calculations	Abbreviation Description	
Thickness of buccal bone at 3 mm	BT-3 mm	Thickness of the root's buccal bone three millimeters from the cement-enamel junction. (CEJ)
Thickness of buccal bone at 6 mm	BT-6 mm	The root's buccal bone thickness measured six millimeters from the (CEJ)
Height of bone	BH	The vertical distance that separates the buccal alveolar crest from the facial (CEJ).
Arch width	AR 3-3	Distance between cusp tip of canine on one side and the contralateral tooth.
Buccolingual inclination	Tooth/Occ	Angle between the mesiodistal line of every tooth and occlusal plane.
Molar rotation	MR	Angle measured at 3 mm thick axial section between the molar's buccal surface at the CEJ level and a line perpendicular to the palatal raphe

RESULT

For comparing the variables within the same group, we used paired t-test to find significance, while for comparing the variables between the two groups, we used independent t-test.

The results showed as in table (2) no significant difference within the group except for one variable for Aligner group that was Buccolingual inclination of central incisor to the occlusal plane and two variables for fixed group that were bone height for central incisors and bone height for mesiobuccal root of first molar.

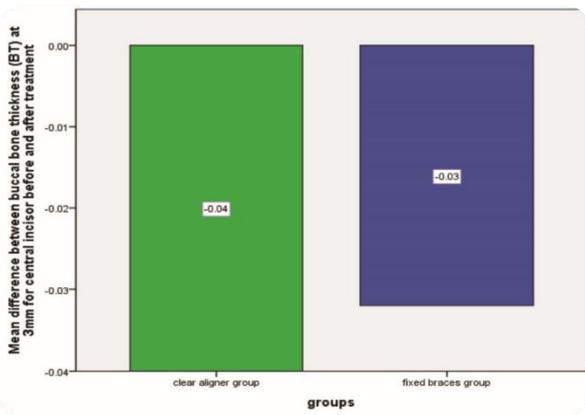
We also found as in table (3) no significant difference between the 2 groups except for the difference between alveolar bone height in bones for central incisor and difference between bone height of alveolar bone for mesiobuccal root of first molar.

Table (2) Show variables that were significant difference within the group.

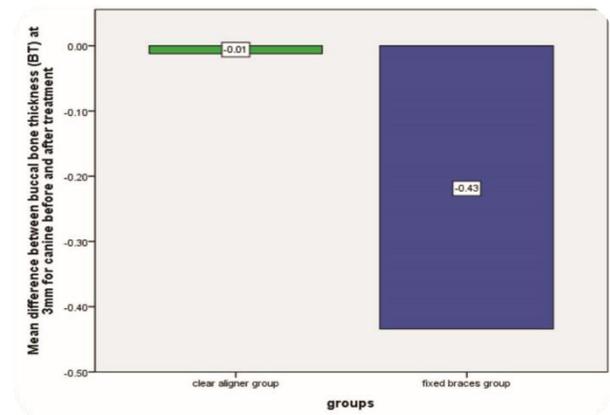
Group	Parameter	pre	post	P value
Aligner group	Inc/Occ (°)	52.48±	57.25	.006
		7.92	±7.95	
Fixed group	BH I	.86 ±.16	1.17 ±.25	.026

Table (3) Show variables that were significant difference between the 2 groups.

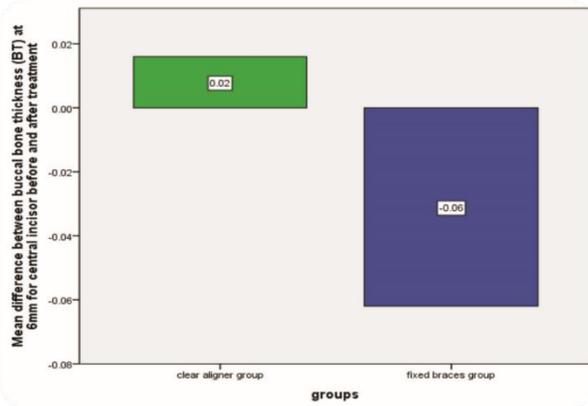
Parameter	Aligner Group		Fixed Group		Test of significance
	Mean	Sd	Mean	Sd	P value
BH I	.01	±.12	.31	±.20	.022
BH mb 1M	-.06	±.20	.66	±.32	.003



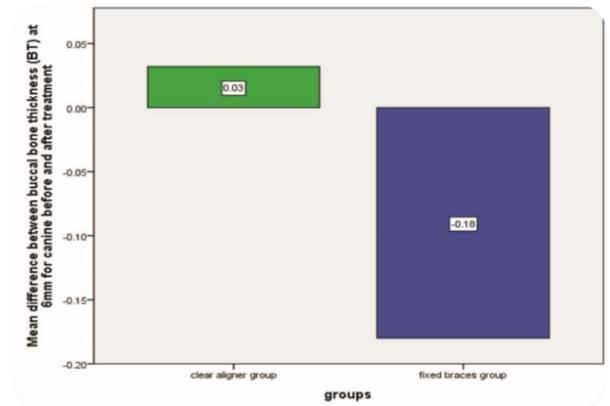
A bar chart comparing Bone thickness-central incisor (3mm) mean changes between groups.



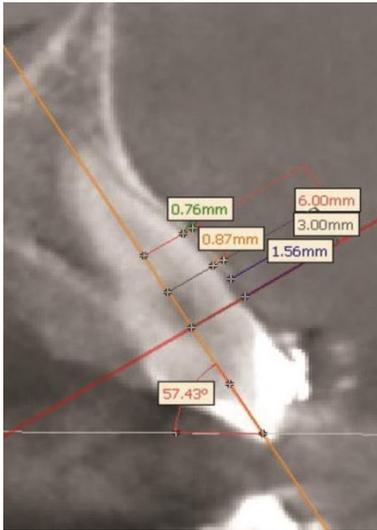
A bar chart comparing Buccal bone-canine (3mm) mean changes between groups.



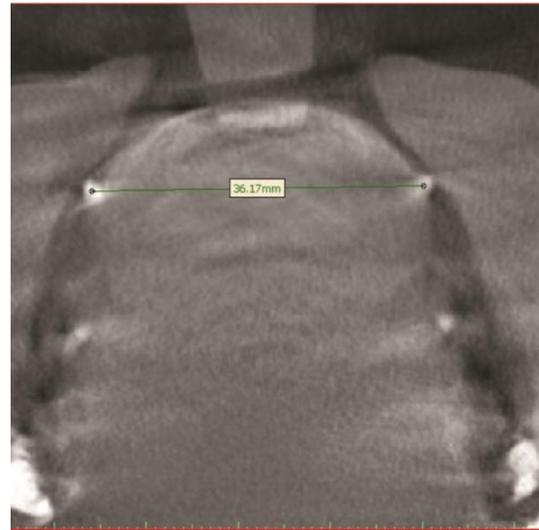
A bar chart comparing Bone thickness-central incisor (6mm) mean changes between groups



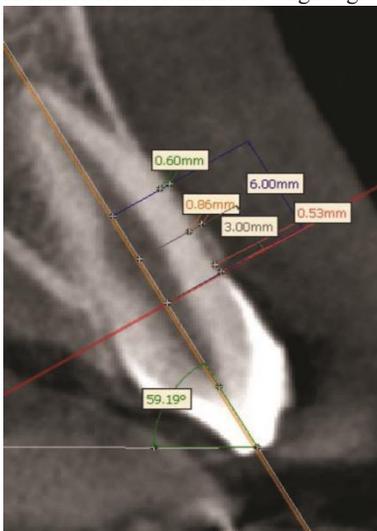
A bar chart comparing Bone thickness-canine (6mm) means changes between groups.



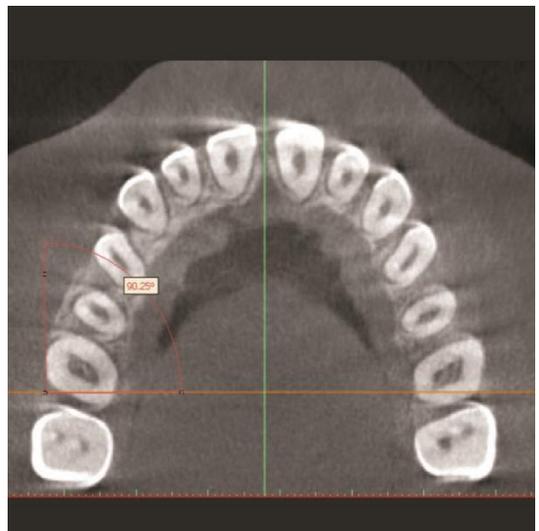
Bone thickness at 3mm &6mm from CE, Bone height and Inclination of canine after treatment for aligner group.



Inter canine width.



Bone thickness at 3mm &6mm from CE, Bone height and Inclination of canine after treatment for fixed group.



Molar rotation

DISCUSSION

The need for appliances that are more aesthetically pleasing and more comfortable than traditional fixed appliances has increased along with the number of adults seeking orthodontic treatment in recent years.

Even though the Invisalign process has been successfully enhanced recently, there is still a little of scientific evidence to support the appliance. This study for calculated the buccal alveolar bone's thickness after orthodontic treatment with clear

aligner. Most literature was done to compare aligner and braces to detect their effect on hygiene, periodontium, arch width, and angulation of the teeth but there is little study to detect change in alveolar bone with aligner as with braces. ⁽¹⁴⁾

The result of this study revealed that the buccal bone thickness for aligner group show change at 3mm and 6mm from cemento-enamel junction most of cases show decrease and other increase and this is logical as pre-treatment position and angulation of the teeth affect bone thickness at

different level in which tooth that are retro-clined after orthodontic treatment will return to normal angulation with decrease in bone thickness at cervical and increase in apical if to move with uncontrol tipping and only increase at cervical if it moved with control tipping , the same for tooth with abnormal position as more buccal positioned tooth if it moved bodily there will be increase in bone thickness at all level of root and if tipped only increase at cervical and decrease at apical all this factors make the change in thickness of alveolar bone non significant {incisors($p = 0.47$) canine ($p = 0.08$), and mb1M($p=0.22$)}

In a confirmation to this result ,previous study by Ting Jianga et al.2020, revealed that The lingual crown and buccal root tipping movement in the aligners may be the cause of the increase in fenestration but decrease in dehiscence in the aligner case, as in the mandibular canines, following treatment, besides the lack of control over root movement with aligners, there may be additional factors contributing to the decreased precision in bone defect prediction, This phenomena may originated from the fact that clear aligners primarily move teeth by tipping. Therefore, future research should take into account additional variables like the type of tooth and the direction and degree of root movement.⁽¹⁵⁾

The result of this study revealed that the bone height for aligner group which represents the distance from CEJ to the crest of alveolar bone also show change in which some case show decreases and other not that result in non significant reduction of bone height {central incisors ($p=0.83$), canine($p=0.73$), mesiobuccally root of first molar ($p=0.52$)} However, little study measured the bone height change of maxillary alveolar bone but Ting Jianga et al.2020 Measured total bone volume of maxillary teeth and show the volume average of alveolar defects for each tooth (computed exclusively for individuals with alveolar defects prior to, or following treatment), The results before treatment were not significantly

different from those measured with post treatment, and this can confirm the result of this study.⁽¹⁵⁾

The result of our study revealed that the Inter canine width for aligner group which is the distance between cusp tip of maxillary canine also show change and non significant increase between cases however most study show significant difference as by Roberta Lione et al. Angle Orthod.2021;91:433–440. (Maxillary arch formation using the Invisalign system: Examination of dental expansion movements on digital dental casts: demonstrate that, with the exception of measurements at the upper second molars, statistically significant differences were found for all measurements. The upper first and second premolars at T2 showed the largest increases in maxillary width, measuring +3.5 mm for the first and +3.8 mm for the second.⁽¹⁶⁾

This difference in present value may be due to the more buccal position of canine in some cases in our study. This study's findings showed that the buccolingual inclination of the teeth to the occlusal plane for aligner group maxillary incisors show significant differences ($p=0.06$) while canine($p=0.36$) and first molar($p=0.73$) show nonsignificant change and this can be matched with result of study by Waseem Kassas et al. 2013 World Federation of Orthodontists, Evaluation of Invisalign treatment results through application of the ABO Model Grading System show the results for the pre- and post-treatment comparisons that the scores for buccolingual inclination considerably improved ($P=0.024$) and when used for mild to moderate malocclusions, Invisalign effectively corrected buccolingual inclination and tooth alignment, but it negatively impacted posterior occlusal contacts and occlusal relationships.⁽¹⁷⁾

The result of this study revealed that the Molar rotation for aligner group which represents angel between tangent to the buccal surface of the first molar and perpendicular to median palatine raphe show non-significant increase in molar



rotation($p=0,5$), no previous study supports these results.

The result of our study suggested that the buccal bone thickness for fixed group at 3mm and 6mm from cemento-enamel junction show decrease in some case and increase in other at both 3mm and 6mm level which result in non-significant change in bone thickness and this as we explain before in aligner group depend on pretreatment inclination of teeth and direction and type of movement.

In a confirmation to this result, previous study by Paulo Roberto Barroso Picanço et al. 2013(Examining the differences in alveolar bone thickness between extraction and non-extraction cases in the maxillary incisor region using computerized tomography) demonstrate a non-significant shift in the anterior teeth's alveolar bone thickness in non-extraction group except for labial cervical third which show significant reduction due to protrusion of the teeth.⁽¹⁸⁾

Another study confirms our result by Udom Thongudomporna et al. Angle Orthod. 2015; 85:549–554 (Changes in the thickness of the anterior maxillary alveolar bone as a result of incisor proclination and extrusion) show none of the labial alveolar thickness parameters changed significantly.⁽¹⁹⁾

While other study shows significant decrease of buccal alveolar bone after orthodontic therapy in earlier CBCT and CT investigations by Juliana F. Moraisa et al. Angle Orthod. 2018; 88:748–756 showed that at the central incisors and mb1M, the thickness and height of the buccal alveolar bone were significantly reduced.⁽²⁰⁾

The result of this study revealed that reduction in bone height which is significant at incisors ($p=0,020$) and mesiobuccally root of first molar ($p=0,01$) and non-significant at canine ($p=0,07$). Previous study confirms this result by Juliana F. Moraisa et al. Angle Orthod. 2018; 88:748–756

showed a significant decrease in the buccal bone's height and thickness at the mb1M and central incisors.⁽²⁰⁾

The result of this study revealed that the Inter canine width for fixed group which is the distance between cusp tip of maxillary canine also show non-significant increase, However other study by Tulin (Ugur) Taner et al. (Am J Orthod Dentofacial Orthop) 2004; 126:464-76 showed that, With the exception of the inter central width, all maxillary tooth distances increased dramatically during orthodontic treatment..⁽²¹⁾ As we explain before in aligner that this difference is due to the more buccal and lingual position of canine in some cases which should be taken into consideration.

Another study by Juliana F. Moraisa et al. Angle Orthod. 2018; 88:748–756 showed that the width of maxillary arch was increased significantly. Significant buccal tipping was the primary cause of the widening.⁽²⁰⁾

The result of our study showed that the Buccolingual inclination of the teeth to the occlusal plane for fixed group shows non-significant change between before and after treatment. However several previous studies show significant change in buccolingual inclination as in study by Eric Lina et al. Angle Orthod. 2022; 92:173–179. showed that there were statistically significant changes in buccolingual inclination.⁽⁹⁾

The result of this study revealed that the molar rotation for fixed group showed non-significant change in molar rotation. However, study by Juliana F. Moraisa et al. Angle Orthod. 2018; 88:748–756 showed that the molars rotated significantly mesiobuccally during treatment.⁽²⁰⁾

It should be clear that change in molar rotation depends on pretreatment rotation of molars as preplanned offset of molar tube will change it. The result of this study revealed that the difference in buccal bone thickness between two groups shows non-significant difference between two groups (p

value more than 0,05). No previous study compares between two groups for this variable.

The result of our study revealed that the difference of bone height between two groups shows significant difference at incisors ($p=0,02$) and mesiobuccally root of first molar ($p=0,03$) and non-significant difference at canine ($p=0,09$), No previous study compares between two groups for this variable.

The result of this study revealed that the difference of Inter canine width between two groups show non-significant difference ($p=0,49$). However, study by Lidia Galan-Lopez et al. Korean J Orthod 2019;49(3):140- 149 assessed and found that Invisalign just like braces, could increase dento-alveolar widths in the presence of crowding.⁽²²⁾

The result of our study suggested that the difference of buccolingual inclination of the teeth to the occlusal plane between two groups show nonsignificant difference. This can be matched with result by Eric Lina et al. Angle Orthod. 2022; 92:173–179. that showed non-significant difference in buccolingual inclination between two group.⁽⁹⁾

The result of our study showed that the difference of molar rotation between two shows non-significant difference between two groups ($p=0,7$), No previous study compares between two groups for this variable

CONCLUSION

Bone height reduction in aligner group is lower than in fixed, while there is no significant difference representing bone thickness.

RECOMMENDATIONS

More clinical studies are required to give a strong evidence and information about the bone

height, thickness and changes related to orthodontic treatment with clear aligner.

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الأزهر مجلة أسبوت لطب الأسنان

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تقييم تأثير التقويم الشفاف على العظم السنخي الشدقي بعد لتقويم (دراسة بالاشعة المخروطية)

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الملخص :

الهدف: تقييم تأثير التقويم الشفاف على العظم السنخي الشدقي بعد التقويم.

المواد والاساليب: الدراسة احلالية تتكون من 14 مريضاً (ذكور، إناث) تتراوح أعمارهم بني 15-25 سنة ممن يعانون من سوء الإطباق البسيط إلى المتوسط والذين تم اختيارهم عشوائياً وقسموا إلى مجموعتين: مجموعة التقويم الشفاف و المجموعة الثابتة، تم تحضير المجموعتين للعلاج التقويمي. ومجموعات التقويم والأسلاك تتغير بالتسلسل. باستخدام التصوير المقطعي المحوسب قبل وبعد علاج تقويم الأسنان أجريت هذه الدراسة على فحوصات

النتائج: كلا التقويم الشفاف و الثابت ليس لها تأثير معنوي على سمك العظام. ومع ذلك، يظهر ارتفاع العظام فرقاً كبيراً بين المجموعتين.

الخلاصة: انخفاض ارتفاع العظام في مجموعة التقويم الشفاف أقل مما هو عليه في مجموعة التقويم الثابت، بينما لا يوجد فرق كبير يمثل سماكة العظام.

الكلمات المفتاحية: التقويم الشفاف، العظم السنخي الشدقي تقويم الاسنان، الاشعة المخروطيه، اعوجاج الاسنان

