# Buccal Alveolar Bone Thickness Assessment using CBCT before and after Orthodontic Treatment with Passive Self-Ligating Brackets: A Clinical Study

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**Abstract:** ***Objective**: The aim of the study was to assess and evaluate buccal alveolar bone thickness at different regions of maxilla by using Cone Beam Computed Tomography (CBCT) taken at pre-treatment and post orthodontic alignment intervals with the help of passive self-ligating brackets. **Methods**: This clinical study was carried out in Department of Orthodontics and Dentofacial Orthopaedics of a reputed Private Dental College. The study population was 15– 40-year-old subjects with sample size (n=16) whose CBCT scanned images were obtained. A simple random sampling technique was used. **Results**: In comparison between pre-treatment and post-treatment buccal alveolar bone thickness the mean value for orthodontic buccal alveolar bone thickness decreases post orthodontic alignment. **Conclusion**: Orthodontic alignment with Damon™ Q self-ligating appliance generated dental arch expansion mainly due to tipping of teeth.*

**Keywords:** Buccal Alveolar Bone Thickness, CBCT, Orthodontic Treatment, Passive Self-Ligating Brackets, Dental Arch Expansion.

## 1. Introduction

The Damon system was first introduced in the 1990s and incorporates low friction and low force wire technology with the use of passive self-ligating brackets. The general philosophy underlying this system is to approximate biologically induced tooth moving forces that results in the alteration of the arch form. The new arch form is adapted from the basic arch form and is "physiologically determined", while creating a new equilibrium that allows the arch to reshape itself to accommodate the full complement of teeth.[1]

The Damon philosophy is based on the principle of using just enough force to initiate tooth movement—the threshold force. The underlying principle behind the threshold force is that it must be low enough to prevent occlusion of the blood vessels in the periodontal membrane to allow the cells and the necessary biochemical messengers to be transported to the site where bone resorption and apposition will occur and thus permit tooth movement. A passive self-ligation mechanism has the lowest frictional resistance of any ligation system. Thus, the forces generated by the arch wire are transmitted directly to the teeth and supporting structures without absorption or transformation by the ligature system.[3]

CBCT was introduced to dentistry in 1998 in Europe and approved for use in the USA in 2001. Since then, CBCT technology has undergone a rapid evolution, driven largely by the demands of each speciality for accurate, reproducible and safe three-dimensional (3D) images. In orthodontics, 3D imaging can help unravel the complexity of dental and skeletal malocclusions and improve diagnosis and treatment planning in specific case types. The varied utilization of CBCT by clinicians for orthodontic purposes exists within the context of research evidence, published case reports or anecdotal observations on a broad spectrum of cases ranging from impacted teeth to temporomandibular joint (TMJ) morphology. Several of these studies show that CBCT provides clinically relevant information and novel 3D research data. CBCT has also been used to assess 3D craniofacial anatomy in health and disease and of treatment outcomes including that of root morphology and angulation, alveolar boundary conditions, maxillary transverse dimensions and maxillary expansion; airway morphology, vertical malocclusion and obstructive sleep apnoea; TMJ morphology and pathology contributing to malocclusion; and temporary anchorage devices.

In the present study, we evaluated how Damon™ Q passive self- ligating brackets impact the buccal alveolar bone thickness and buccal bone height before and after orthodontic alignment of maxillary teeth using CBCT. With this study we can understand how passive self-ligating brackets work in terms of arch development.

## 2. Materials and Methods

***Method of selection of study subjects:***
The selection of study subjects was based on inclusion and exclusion criteria:

**Inclusion criteria:**
1) Patients in the age group between 15-40 years.
2) Non-extraction treatment.
3) Narrow maxillary arch.
4) Moderate to severe crowding.
5) No interproximal reduction.
6) No surgical intervention.
7) Initial and final CBCT records of maxilla.
8) No missing teeth, excluding the second and third molars.

**Exclusion criteria:**
1) Patients who had undergone previous active orthodontic treatment.
2) Patients with spacing in either of the arches.
3) Missing teeth, excluding second and third molars.
4) Patients with pathology associated with head and neck area.
5) Critical anchorage cases requiring orthodontic extraction.

1) In this study, pre-existing CBCT scanned images fulfilling the inclusion criteria were collected from different CBCT unit-equipped colleges and CBCT centres.


**Figure 2:** Pre-existing CBCT scanned images.

2) By using CS 3D Imaging software (Carestream Health Inc.) slices at different sites of the maxillary bone region were reconstructed from the image.


**Figure 3:** CS 3D Imaging software (Carestream Health Inc.).

3) The following two sites were reconstructed:
a) Buccal Alveolar Bone thickness at 3 mm from Cementoenamel junction of each individual teeth from central incisor to first molar in the maxillary arch.
b) Buccal Bone Height - By measuring the distance between Cementoenamel Junction and alveolar crest of each individual teeth from central incisor to first molar.

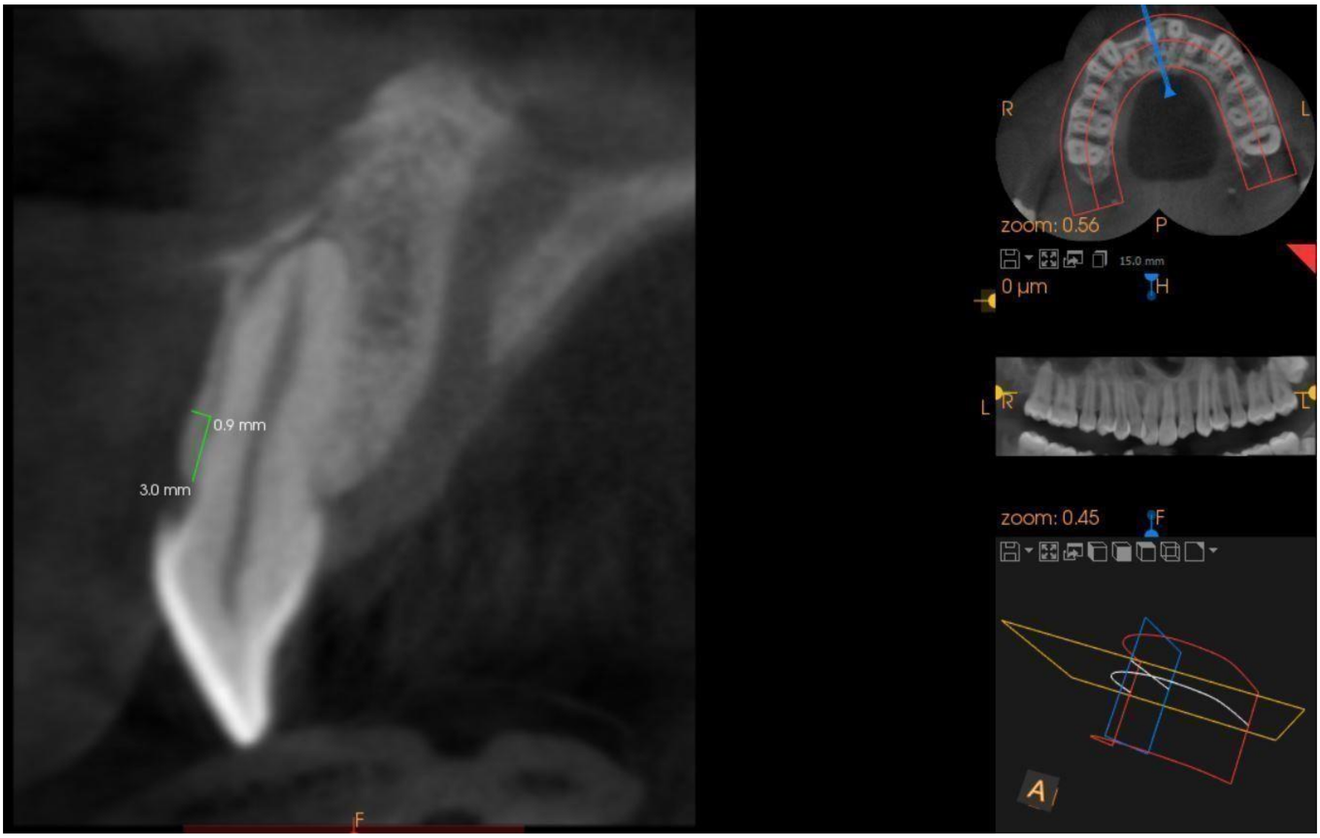



**Figure 4 (b):** Buccal Alveolar bone thickness at 3mm from cementoenamel junction

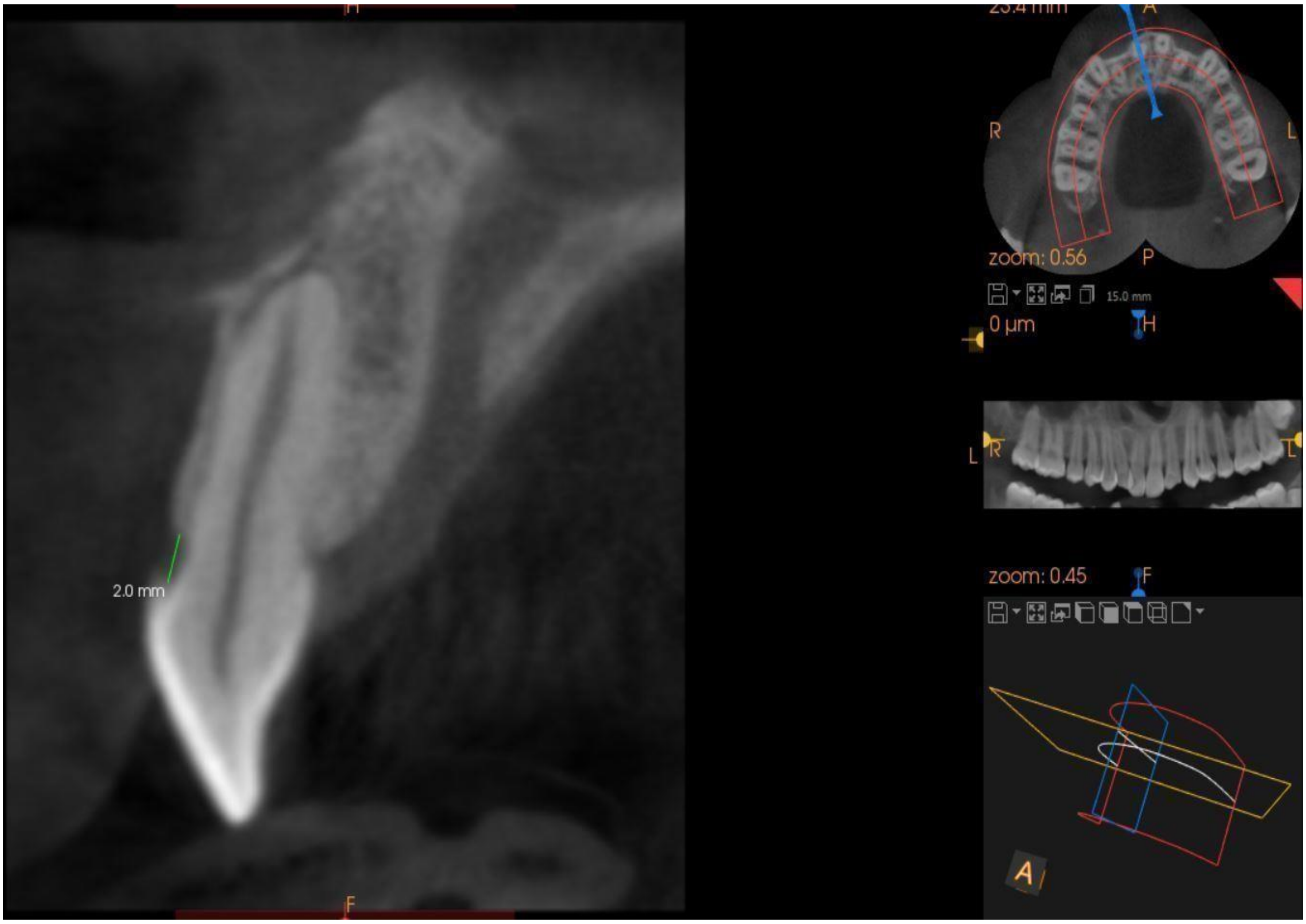



**Figure 4 (b):** Buccal bone height- Distance between cementoenamel junction and alveolar crest

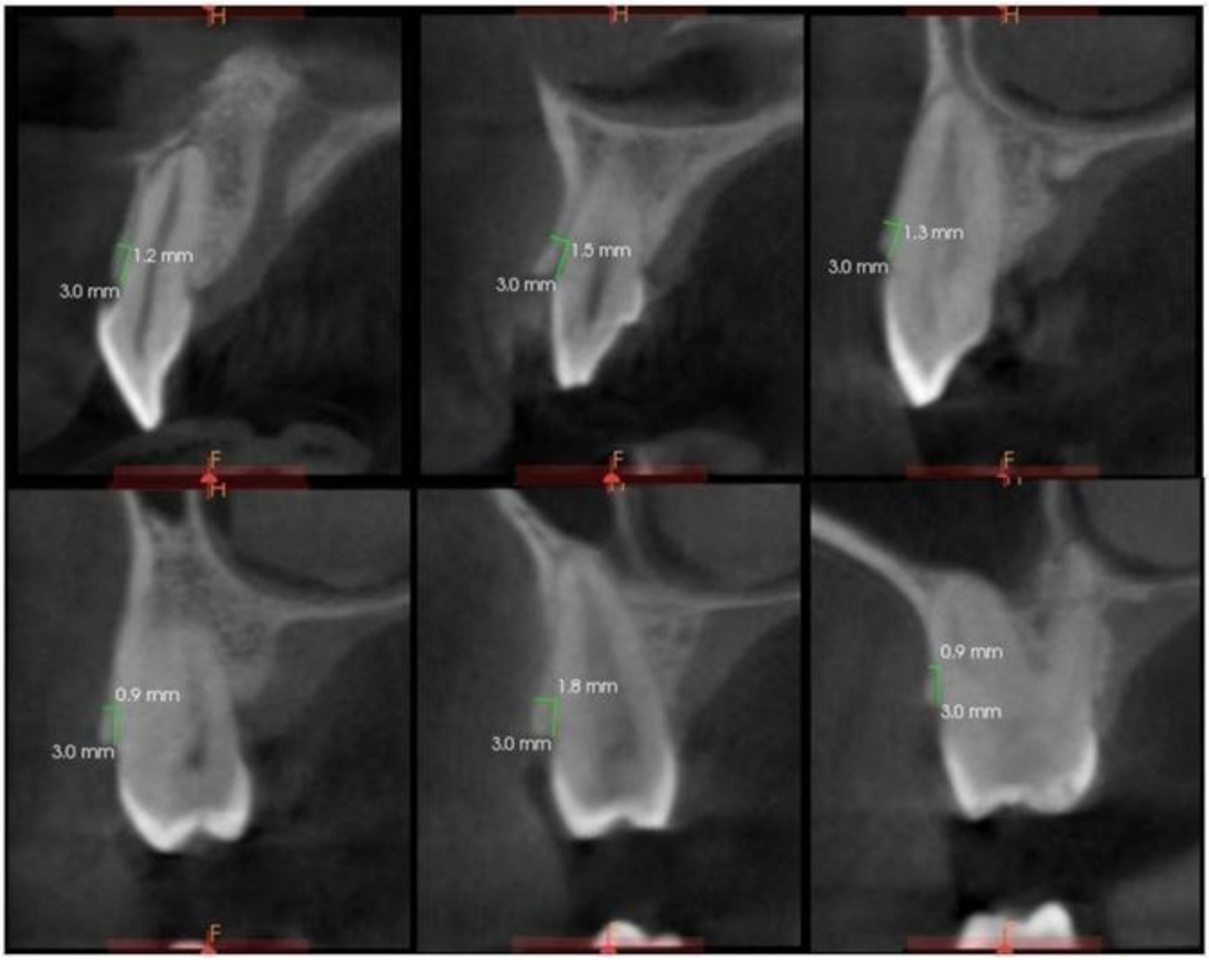



**Figure 5:** First measurement of depth (buccal alveolar bone thickness) carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and at first molar region

4) The first measurement of depth was buccal alveolar bone thickness carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and first molar region as shown in the figure below.

5) The second measurement of depth was buccal bone height which was carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and first molar region as shown in the figure below.

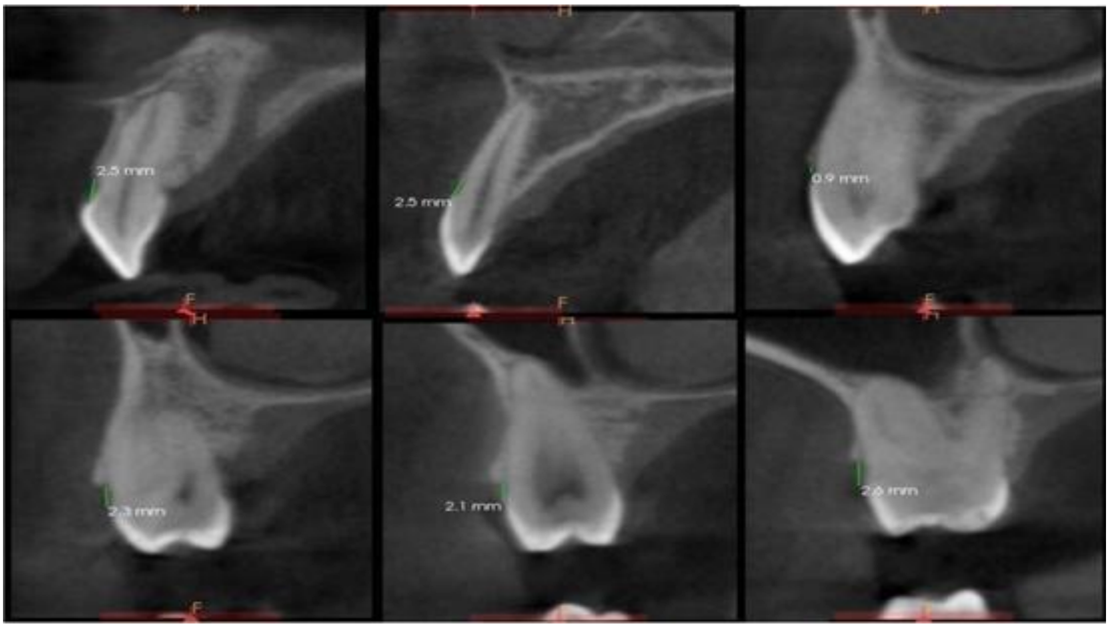



**Figure 6:** Second measurement of depth (buccal bone height) carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and at first molar region

6) The measurements for buccal alveolar bone thickness and buccal bone height were repeated for the same teeth of opposite quadrant in the maxillary arch.

7) The third measurement of depth was buccal alveolar bone thickness after alignment of maxillary arch was carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and first molar region as shown in the figure below.

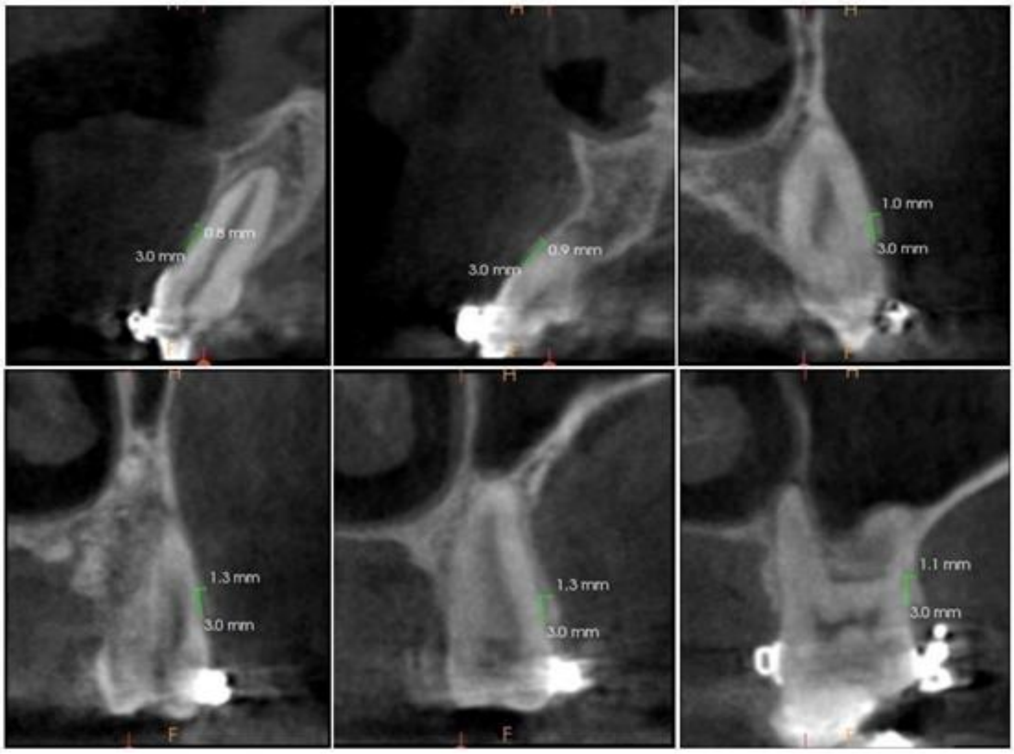



**Figure 7:** Third measurement of depth (buccal alveolar bone thickness) after orthodontic alignment carried out at central incisor region followed by lateral incisor, canine, first premolar, second premolar and at first molar region

8) The fourth measurement of depth was buccal bone height after alignment of maxillary arch which was carried out at central incisor followed by lateral incisor, canine, first premolar, second premolar and first molar as shown in the figure below.

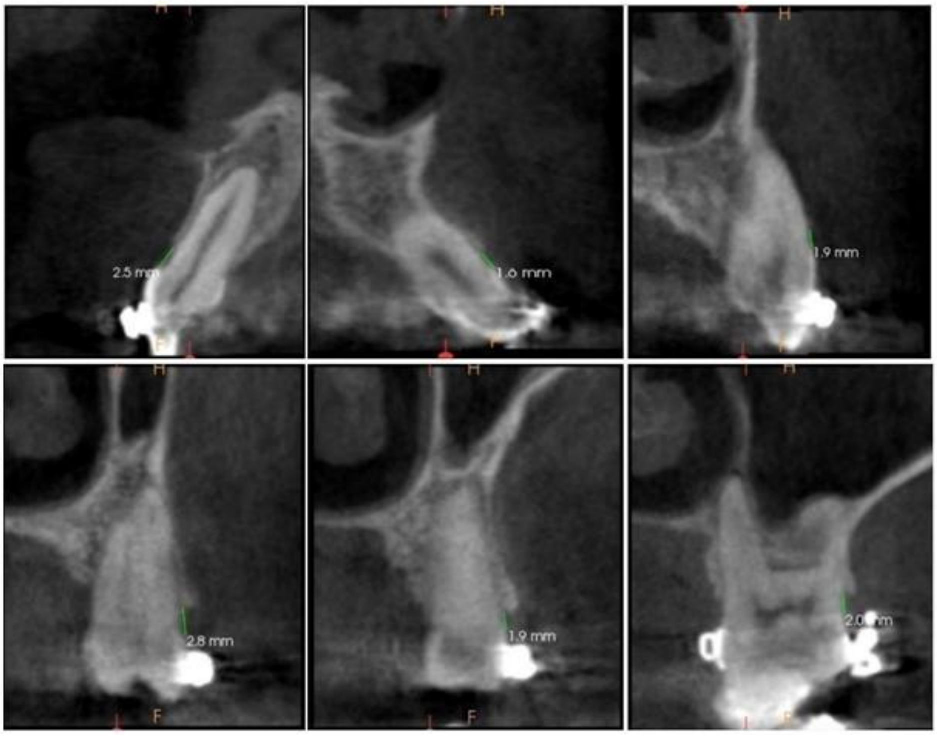
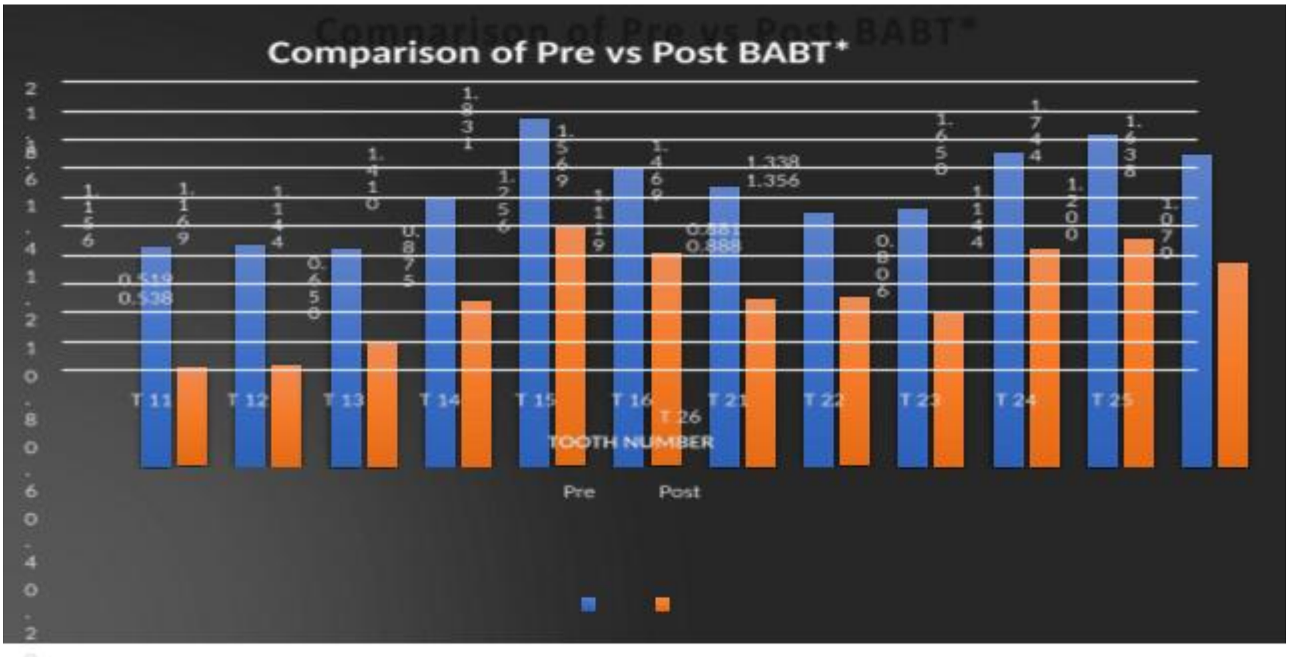



**Figure 8:** Fourth measurement of depth (buccal bone height) after orthodontic alignment carried out at central incisor region following by lateral incisor, canine, first premolar, second pre molar and first molar region and at first molar region

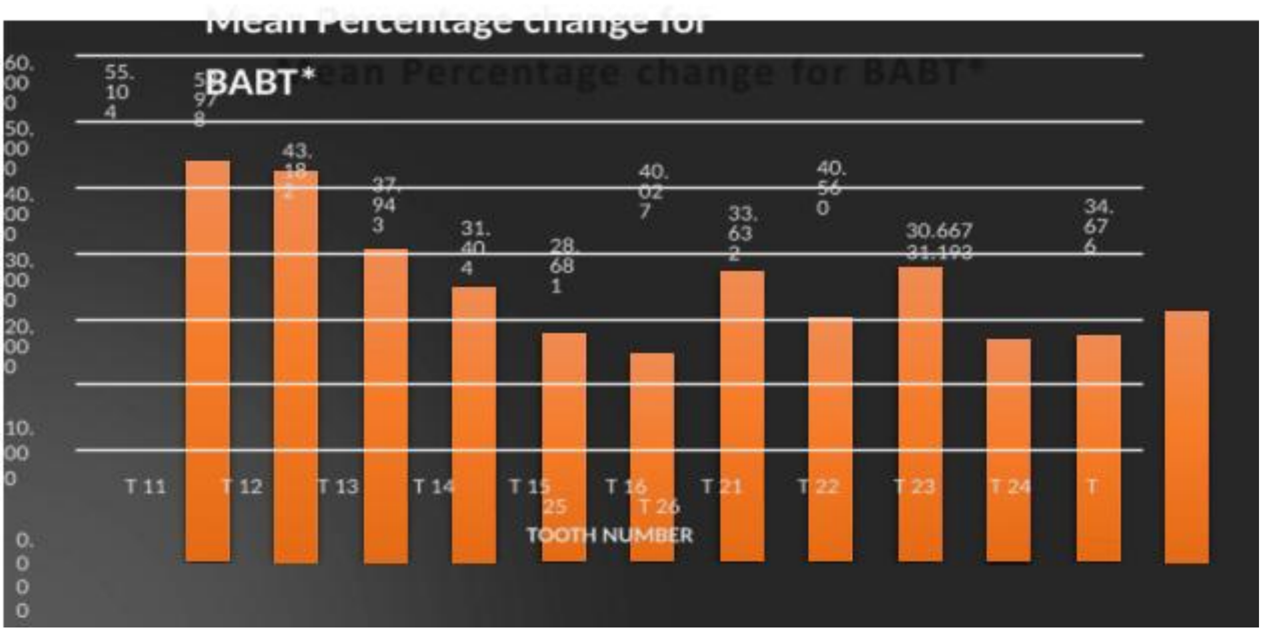
9) The measurements for buccal alveolar bone thickness and buccal bone height post alignment were repeated for the same teeth of opposite quadrant in the maxillary arch.

## 3. Results




**Graph 1:** Bar graph showing comparison of pre- treatment Vs Post- Treatment buccal alveolar bone thickness

In graph 1(a) of comparison between pre-treatment and post-treatment buccal alveolar bone thickness we can clearly see the mean value for orthodontic buccal alveolar bone thickness decreases post orthodontic alignment.
BABT* denotes the Buccal Alveolar Bone Thickness




**Graph 2:** Bar Graph showing mean percentage for buccal alveolar bone thickness

The graph 2(a) shows the mean percentage change for buccal alveolar bone thickness and it shows that the percentage change is maximum for right central incisor.

## 4. Discussion

The main purpose of this study was to assess the effects on the maxillary buccal alveolar bone thickness and bone height using a passive self-ligating appliance. Tissue response to orthodontic forces can occur ‘‘through the bone’’ or ‘‘followed” by the alveolar bone.[53] In this study, teeth moved mostly ‘‘through the alveolar bone’’ and not centred in the bone, which proved that dental expansion occurs by tipping movements and not by arch development as suggested by Damon philosophy.

In this study there was a buccal bone recession of about 0.7

mm at the central incisor. Garlock. et al.[13] in their study evaluated the marginal alveolar bone height in the anterior mandible after orthodontic treatment assessed any correlations between morphologic and treatment changes. They collected 57 pre-treatment and posttreatment cone-beam computed tomography images (17 male and 40 female subjects; 22 Class I, 35 Class II; average age, 18.7 ± 10.8 years; average treatment time, 22.7 ±7.3 months) to measure cortical bone thickness, ridge thickness, distance from the apex to the labial cortical bone, and the distance from the cementoenamel junction to the marginal bone crest. Additionally, changes in the cementoenamel junction to the marginal bone crest distance were correlated with pre-treatment measurements and treatment changes. They reported on average 1.12 mm of buccal bone recession at the mandibular central incisor, with high variability after non-extraction treatment with a self-ligating appliance. In this study maxillary arch was taken into consideration and 0.7 mm of buccal bone recession was reported at the central incisor which was comparatively less as compared to the previous study.

In the current study the mean reduction in buccal bone thickness was around 0.5 mm; and mean increase in the buccal bone height was 1.15 mm. Buccal tooth movement and bone dehiscence have been linked in animal investigations, where buccal tooth movement with mild forces increased the distance between the cementoenamel junction and the alveolar crest.

## 5. Conclusion

The following conclusions can be drawn from the study: -

- Orthodontic alignment with Damon™ Q self-ligating appliance generated dental arch expansion mainly due to tipping of teeth.
- From the current study it can be concluded that the buccal bone height increased significantly at the lateral incisors with the mean percentage change recorded to be 76.13 %.
- Initial bone thickness, severity of crowding and the amount of expansion required during treatment had a weak, but significant, impact on the buccal bone reduction.
- Significant bone loss (in terms of thickness) was observed at the maxillary central incisors and the mesio-buccal root of the first molars.
- The overall clinical agreement between CBCT and direct measurements was statistically significant and found to be greater for buccal bone height than for buccal bone thickness.

## References

[1] Askari M. CBCT assessment of dental and skeletal arch changes using the Damon vs. conventional (MBT) system (Doctoral dissertation, University of Maryland, Baltimore).

[2] Morais JF, Melsen B, de Freitas KMS, Castello Branco N, Garib DG, Cattaneo PM. Evaluation of maxillary buccal alveolar bone before and after orthodontic alignment without extractions: A cone beam computed tomographic study. Angle Orthod. 2018;88(6):748-756.

[3] Birnie D. The Damon passive self-ligating appliance system. InSeminars in Orthodontics 2008 Mar 1 (Vol. 14, No. 1, pp. 19-35). WB Saunders.

[4] Vajaria R, BeGole E, Kusnoto B, Galang MT, Obrez A. Evaluation of incisor position and dental transverse dimensional changes using the Damon system. Angle Orthod. 2011 Jul;81(4):647-52.

[5] Rhoden FK, Maltagliati LÁ, de Castro Ferreira Conti AC, Almeida-Pedrin RR, Filho LC, de Almeida Cardoso M. Cone Beam Computed Tomography-based Evaluation of the Anterior Teeth Position Changes obtained by Passive Self-ligating Brackets. J Contemp Dent Pract. 2016 Aug 1;17(8):623-9.

[6] Kapila SD, Nervina JM. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofac Radiol. 2015;44(1):20140282.

[7] Lucchese A, Manuelli M, Albertini P, Ghislanzoni LH. Transverse and torque dental changes after passive self-ligating fixed therapy: A two-year follow-up study. Am J Orthod Dentofacial Orthop. 2019 Jul;156(1):94-103.

[8] Scarfe WC, Farman AG, Sukovic P. Clinical applications of cone-beam computed tomography in dental practice. J Can Dent Assoc. 2006 Feb;72(1):75-80.

[9] Berger JL. The influence of the SPEED bracket's self-ligating design on force levels in tooth movement: a comparative in vitro study. Am J Orthod Dentofacial Orthop. 1990 Mar;97(3):219-28.

[10] Cattaneo PM, Treccani M, Carlsson K, Thorgeirsson T, Myrda A, Cevidanes LH, Melsen B. Transversal maxillary dento-alveolar changes in patients treated with active and passive self-ligating brackets: a randomized clinical trial using CBCT-scans and digital models. Orthod Craniofac Res. 2011 Nov;14(4):222-33.

[11] Cobb NW 3rd, Kula KS, Phillips C, Proffit WR. Efficiency of multi-strand steel, superelastic Ni-Ti and ion-implanted Ni-Ti archwires for initial alignment. Clin Orthod Res. 1998 Aug;1(1):12-9.

[12] Damon DH. The rationale, evolution and clinical application of the self-ligating bracket. Clin Orthod Res. 1998;1(1):52-61.

[13] Garlock DT, Buschang PH, Araujo EA, Behrents RG, Kim KB. Evaluation of marginal alveolar bone in the anterior mandible with pretreatment and posttreatment computed tomography in nonextraction patients. Am J Orthod Dentofacial Orthop. 2016 Feb;149(2):192-201.

[14] Hammad S, Fouda A, Giacaman N. A Randomized Clinical Trial to Evaluate Labial Alveolar Bone Thickness and Apical Root Resorption between Two Types of Brackets Using Cone-Beam Computed Tomography. Journal homepage: www. nacd. in Indian J Dent Adv. 2018;9(4):210-6.

[15] Holmes PB, Wolf BJ, Zhou J. A CBCT atlas of buccal cortical bone thickness in interradicular spaces. Angle Orthod. 2015 Nov;85(6):911-9.

[16] Nam HJ, Gianoni-Capenakas S, Major PW, Heo G, Lagravère MO. Comparison of Skeletal and Dental Changes Obtained from a Tooth-Borne Maxillary Expansion Appliance Compared to the Damon System Assessed through a Digital Volumetric Imaging: A Randomized Clinical Trial. J Clin Med. 2020 Sep 30;9(10):3167.

[17] Damon DH. The Damon low-friction bracket; a

biologically compatible straight-wire system. J Clin Orthod. 1998;32:670-80.
[18] Basciftci FA, Akin M, Ileri Z, Bayram S. Long-term stability of dentoalveolar, skeletal, and soft tissue changes after non-extraction treatment with a self-ligating system. Korean J Orthod. 2014 May;44(3):119-27.
[19] Kraus CD, Campbell PM, Spears R, Taylor RW, Buschang PH. Bony adaptation after expansion with light-to-moderate continuous forces. Am J Orthod Dentofacial Orthop. 2014 May;145(5):655-66.
[20] Lineberger MB, Franchi L, Cevidanes LH, Huanca Ghislanzoni LT, McNamara JA Jr. Three-dimensional digital cast analysis of the effects produced by a passive self-ligating system. Eur J Orthod. 2016 Dec;38(6):609-614.