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# Do Self Ligating Bracket systems produce actual Alveolar Bone Expansion?

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***Abstract:*** *Claims about superiority of self- ligating (SL) brackets over the conventional (CL) ones have been escalating with minimal evidence based supporting studies.*

***Aim:****The aim of this clinical study was to compare both systems in affecting the alveolar bone thickness and the type of tooth movement produced during the leveling and alignment phase.*

***Methods:****A split mouth study design was conducted on 13 extraction cases using the SmartClip SL brackets on one side of the mouth and CL brackets on the other one. Leveling and alignment was achieved using four archwires. CBCT's were taken before and after alignment. Measurements of tooth crown and root movement as well as alveolar bone thickness at the canines, premolars and molar regions were performed.*

***Results:****There was a statistically non- significant increase in the buccal inclination of the teeth accompanied by a non- significant decrease in the surrounding buccal cortical thickness in both sides. There was no statistically significant difference between the two sides when different measurementswere compared.*

***Conclusions:****Actual alveolar bone expansion was not evident with the use of self ligating brackets in this study. Both self ligating and conventional bracket designs produced tipping tooth movement. Therefore, the use of SL bracket system offered no advantage over the CL ones in extraction cases regarding both alveolar bone thickness and type of tooth movement.*

***Keywords:****Self-ligating, SmartClip, bone expansion, extraction.*

## I. Introduction

The self-ligating (SL) concept is not new. It has evolved in the early 1930's and presented as the Russell attachment in an attempt to decrease the chairside time. Although this system didn't gain much popularity then, other forms of SL brackets continued to evolve as the EdgeLok bracket [(1)], SPEED [(2)], Activa [(3)], Time [(4)], Damon [(5)], SmartClip [(6)] and many others. The revival of this concept is strongly seen nowadays, and their comparison with the conventional (CL) brackets became one of the most important topics discussed in the orthodontic literature.

Many advantages of SL brackets have been claimed; full and secure wire ligation, better sliding mechanics, possible anchorage conservation, better periodontal health, chair time savings and most importantly less friction with archwires. With the reduced friction and the less force needed to produce tooth movement, less treatment time is required, and finally and most importantly; more expansion and less need for extractions is seen, more alveolar bone regeneration and a healthier periodontium is obtained. It is widely known that the SL systems provide a non- extraction treatment plan resulting in a 'wider arch' despite severe crowding. These claims have been widely spread by the SL dealers and manufacturers without any evidence supporting such claims. The Damon system claims that their brackets allow the body's natural adaptive forces to cause expansion and create space naturally giving a headgear or Frankel like effect through providing a new force equilibrium [(7).] Some authors believe that an advantage of SL brackets can be seen in extraction cases as well [(8, 9)]. In response to these claims, an ample amount of studies and articles have been published. Many in–vitro studies were made comparing the frictional resistance and torque expression in SL and CL brackets, and among different SL systems. Most, if not all of the results showed that the SL brackets generated less friction than the CL brackets and so easier and faster tooth movement was expected to be seen intra-orally. In vitro results showed that expansion without tipping was claimed to be related to each brackets' design, wire sequence, and torque control; yet, wide variations in torque expression have been described [(10, 11)].In vivo studies comparing the pre and post treatment casts of SL and CL systems revealed an increase the transverse dimensions and incisor proclination irrelative to the type appliance used[(12, 13, 14).]Nevertheless, despite the claims regarding the clinical superiority of SL brackets, the literature still lacks evidence based in-vivo studies comparing the SL to CL bracket systems especially in extraction cases, supported by an accurate imaging method evaluating the crown and root positions, and actual changes in the alveolar bone. Accordingly, the aim of this study was to answer the following questions; Does alveolar bone expansion occur with self-ligating bracket system, and whether this expansion, if present, differs in comparison to conventional bracket system? Furthermore, are there any differences in the type of tooth movement produced by both systems?

## II. Materials And Methods

This study was approved by the Research Ethics Committee of the Faculty of Oral and Dental Medicine, Cairo University.All patients' parents were informed about the study procedures and written consents were signed.

A priori power analysis from published article by Catanneo et al[15] showed that required sample size should be above 10 for a power of 80%. An oversizing of the sample was done to compensate for patients' dropouts. Thus, the study was conducted on 15 female subjects presented at the Outpatient Clinic of the Department of Orthodontics, Faculty of Oral & Dental medicine, Cairo University. 13 out of the 15 female patients enrolled in this study completed the leveling and alignment phase as designed.

A Post hock analysis for different variables of the study was done. As for primary outcome which is the cortical bone thickness (total no of patient 13, effect size =2.8 with alpha =0.05), revealed a power >0.90 ( G*power release 3.1.9.2)

**Selection Criteria:**

- Adult female patients with ages ranging from 18- 25 years.
- Class I or Class ll molar relationship with severe crowding needing a treatment plan including the extraction of the upper and lower first premolars.
- Excellent periodontal health.

Pre- treatment records (study models, CBCT, extra and intra oral photographs, periodontal assessment) were done for each patient. In order to test the null hypothesis of our research which stated that SL brackets offer no advantages over the CL brackets in the leveling and alignment phase regarding bone expansion and type of tooth movement, a split- mouth study technique was adopted in all the patients. After 7 days of extraction, bonding of the brackets was done. For each patient, the SmartClipTM SL3 brackets were bonded to both the upper and lower right anterior and posterior teeth in one half of the mouth. The other half received the SmartClipbrackets after being modified through the removal of their NiTi clips by a high speed contra-angle hand piece, transforming them into CL brackets. (Fig. 1)

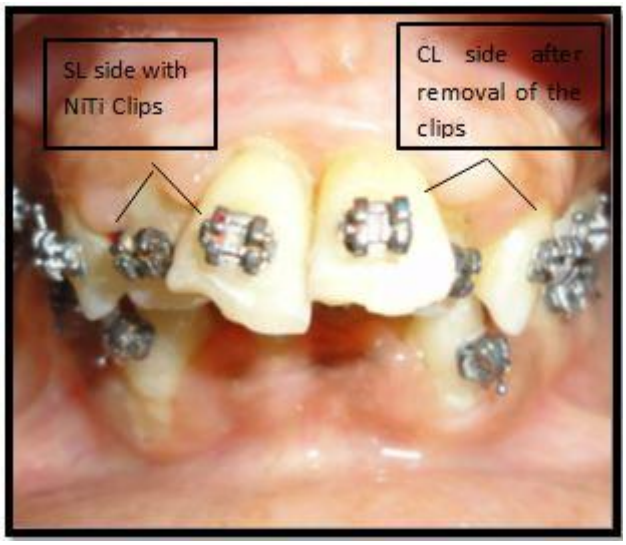



**Figure (1):** The Split- Mouth Technique: The right side showing the SmartClip bracket with its clips, while the left side showing the bracket with no clips.

**Sequence generation (randomization):**

Randomization was performed as a block randomization with a 1:1 allocation. The sequence of the sides receiving SL brackets and other as control was computer generated random numbers. This was done using Microsoft Office Excel 2007 sheet. By writing in the first column numbers from 1 to 26 then in the second column select function RAND() to generate the randomization number. Sorting these numbers was done according to the randomization number so the first column numbers will be randomly distributed. By considering all patients are right sides then take the first 13 random numbers as SL group and second 13 as the CL control group. And automatically the left side will be in the opposite group.

The leveling and alignment phase followed the protocol presented by **Melrose and Wolstencroft** (6). According to that protocol, leveling and alignment started by 0.016'' Ni-Ti, then 0.018''x 0.025'' Ni-Ti ending with a 0.019'' x 0.025'' St.St. wire, leaving each wire in place for 8 weeks. This protocol was then modified to

start by a leveling wire 0.014''NiTi, followed by the 0.016'' NiTi wire in cases of severe malalignment of upper and lower arches. The 8 weeks interval between each archwire was sometimes decreased, when the archwire was seen to be passive at shorter periods (fig.2)

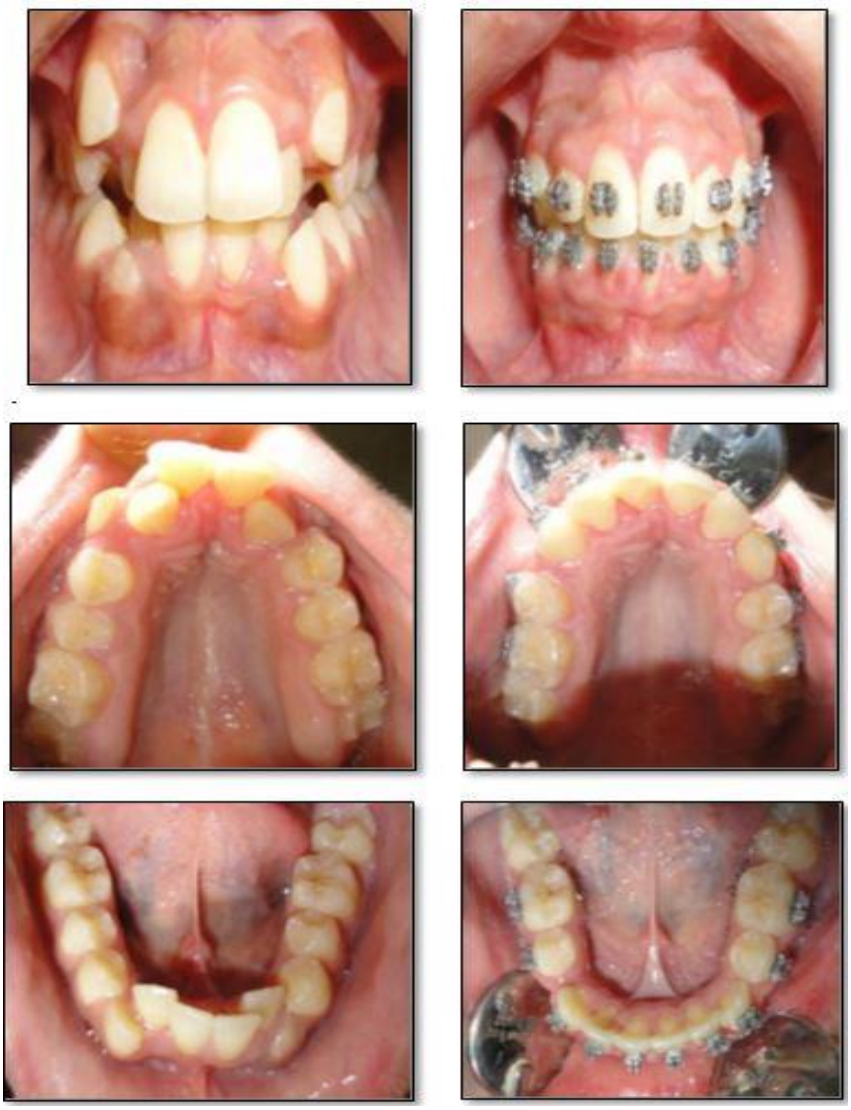


**Figure (2):** Pre and post alignment photographs.

In cases of severely malaligned or rotated teeth, stainless steel ligatures were used to engage the severely malaligned teeth to the main archwire in both the SL and CL sides. Regular elastomeric o-ties were used to ligate the archwire to the CL brackets. To make the patient less oriented by the difference, silver o-ties were chosen. Another CBCT was taken after the completion of the alignment phase.

By using the Anatomage image processing software, a fully reconstructed 3D volumetric image with sagittal, coronal, and axial multiplanar projections were generated. Landmarks localization was determined by using the generated 3 multiplanar projections. Selected points were then assessed in the 3D volumetric image to confirm accurate landmark localization in all 3 planes of space. For each of the canine, second premolar and first molar in each quadrant of the mouth, the following was measured and compared using the pre and post alignment CBCT's as shown in table (1)

**Table (1): Description of each measurement used.**

| Measurement | Description |
|---|---|
| 1.Cortical thickness (Buccally) | Distance between the most antero-superior point on the buccal cortical plate of bone of each tooth (approximately 2-3 mm from the cemento- enamel junction) and its correspondent point on |

| | |
|---|---|
| | the root of the same tooth (fig.3). |
| 2.Buccal Bone Position | Distance between MSP and the most anetro- superior point on the buccal cortical plate of each tooth (fig.4). |
| 3.Palatal Bone Position | Distance between MSP and the most anetro- superior point on the palatal cortical plate of each tooth (fig.4) |
| 4. Canine Position | Distance between Mid-sagittal plane (MSP) and canine cusp tips. |
| 5. Premolar Position | The average of the distance between MSP and; buccal cusp tip and central fossa of second premolars. |
| 6. Molar Position | The average of the distance between MSP and; mesiobuccal cusp tip and central fossa of first molars. |

**Fig (3):***Cortical thickness*: Distance between the most antero-superior point on the buccal cortical plate of bone of each tooth (red point) and its correspondent point on the root of the same tooth (black point).

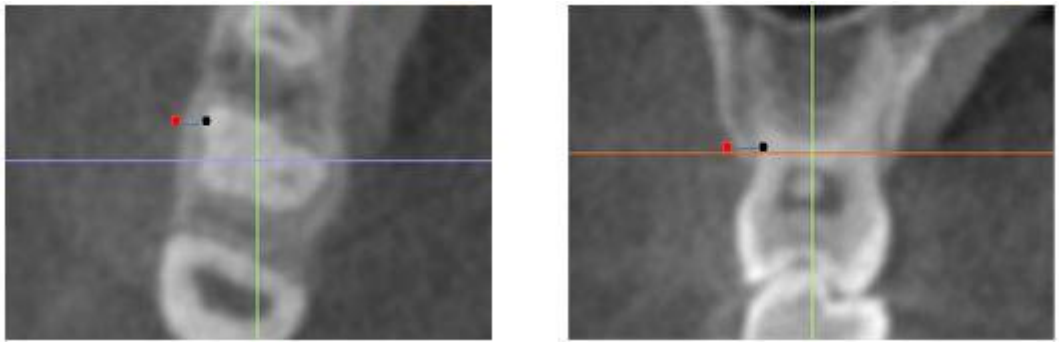
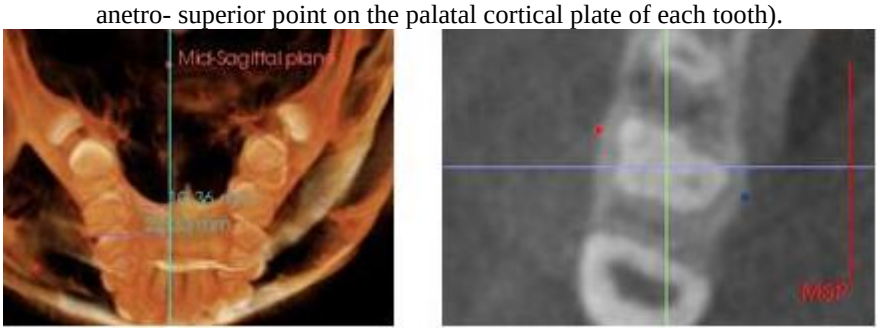


**Fig (4):***Buccal Bone Position*: distance between MSP and red point (the most anetro- superior point on the buccal cortical plate of each tooth). *Palatal Bone Position*: Distance between MSP and blue point (the most anetro- superior point on the palatal cortical plate of each tooth).




**Inter and intra observer reliability:**

For precision, each measurement was measured twice at different time intervals to calculate the intra-observer reliability. To measure inter- observer reliability, all the aforementioned measurements were measured again by another observer.Statistical analysis was performed by Microsoft Office 2013 (Excel) and Statistical Package for Social Science (SPSS) version 20.Data were presented as mean, standard deviation (SD), median, and interquartile range (IQ) values.The significant level was set at $P \leq 0.05$.Kolmogorov-Smirnova and Shapiro-Wilk tests was used to assess data normality. ANOVA for repeated measures was used to compare between measures. Wilcoxon signed rank test was used to compare between non parametric data. Pearson correlation was used to assess correlation between measures.

**Intra-** and inter-observer reliability (agreement) was measured using Cronbach's alpha reliability coefficient. Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient is to1.0, the higher the reliability.

## III. Results

13 out of the 15 patients completed the study to the end of the levelling and alignment stage as designed. The leveling and alignment phase was completed nearly in 7 months. The SL side showed less chairside time and better patient acceptance than the CL one.

There was very good intra-observer and inter observer agreement regarding all measurements of SL and CL groups (tables 2& 3).

**Table (2): Results of Cronbach's alpha coefficient for inter-observer reliability CBCT measurements:**

| Intraclass Correlation | 95% Confidence Interval | | F Test with True Value 0 | | | | Cronbach's Alpha |
|---|---|---|---|---|---|---|---|
| | Lower Bound | Upper Bound | Value | df1 | df2 | Sig | |
| .981 | .970 | .989 | 106.371 | 63 | 63 | .000 | 0.991 |

**Table (3): Results of Cronbach's alpha coefficient for intra-observer reliability of CBCT measurements:**

| Intraclass Correlation | 95% Confidence Interval | | F Test with True Value 0 | | | | Cronbach's Alpha |
|---|---|---|---|---|---|---|---|
| | Lower Bound | Upper Bound | | df1 | df2 | Sig | |
| .979 | .965 | .987 | 0.991 | 63 | 64 | .000 | 0.991 |

When the measurements of the maxilla were compared to those of the mandible on each side (SL and CL), no statistically significant difference was found between the results, so both maxillary and mandibular measurements for each side were pooled together.

Comparison between pre alignment and post alignment measurements at the canine, premolar and molar regions within each group ( the SL side and the CL side) in both maxilla and mandible:

**Both groups followed the same pattern in their results;**

- **Canine measurements:** there was a statistically non- significant increase in the 'tooth position' and 'palatal bone position' measurements. As for the 'buccal bone position' and the 'cortical thickness', there was a statistically non- significant decrease. (table 4)

**Table 4: comparison between the pre and post alignment CBCT canine measurements within the SL and CL groups using ANOVA for repeated measures.**

| tooth | side | measurement | time | Mean | Std. Error | 95% Confidence Interval | | P value |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | |
| canine | SL group | Tooth position | Pre | 14.461 | .563 | 13.221 | 15.701 | 0.885 |
| | | | Post | 14.688 | 1.173 | 12.107 | 17.269 | |
| | | Palatal bone position | Pre | 8.293 | .468 | 7.262 | 9.323 | 0.067 |
| | | | Post | 9.822 | .520 | 8.677 | 10.968 | |
| | | Buccal bone position | Pre | 14.143 | .680 | 12.646 | 15.639 | 0.67 |
| | | | Post | 14.808 | 1.111 | 12.362 | 17.254 | |
| | | Cortical thickness | Pre | .758 | .050 | .647 | .869 | 0.166 |
| | | | Post | .646 | .056 | .522 | .770 | |
| | CL group | Tooth position | Pre | 15.475 | 1.074 | 13.111 | 17.840 | 0.295 |
| | | | Post | 17.713 | 1.646 | 14.090 | 21.335 | |
| | | Palatal bone position | Pre | 9.193 | .875 | 7.268 | 11.119 | 0.203 |
| | | | Post | 11.652 | 1.532 | 8.279 | 15.024 | |
| | | Buccal bone position | Pre | 15.237 | .752 | 13.581 | 16.893 | 0.227 |
| | | | Post | 17.513 | 1.618 | 13.952 | 21.073 | |
| | | Cortical thickness | Pre | .838 | .076 | .672 | 1.005 | 0.156 |
| | | | Post | .616 | .110 | .375 | .857 | |

- **2nd premolar measurements:** There was a statistically non- significant increase in the 'tooth position' and 'palatal bone position' measurements. The 'buccal bone position' measurement showed a non-significant decrease while the 'cortical thickness' showed a statistically significant decrease. (table 5)

**Table (5): comparison between the pre and post alignment CBCT 2nd premolars measurements within the SL and CL groups using ANOVA for repeated measures.**

| tooth | side | measurment | time | Mean | Std. Error | 95% Confidence Interval | | P value |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | |
| 2nd premolar | SL group | Tooth position | Pre | 16.377 | .528 | 15.216 | 17.538 | 0.922 |
| | | | Post | 16.540 | 1.378 | 13.506 | 19.573 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Palatal bone position | Pre | 13.342 | .519 | 12.199 | 14.484 | 0.741 |
| | | | Post | 12.937 | .895 | 10.967 | 14.908 | |
| | | Buccal bone position | Pre | 22.070 | .543 | 20.876 | 23.265 | 0.417 |
| | | | Post | 20.533 | 1.527 | 17.172 | 23.893 | |
| | | Cortical thickness | Pre | 1.415 | .120 | 1.152 | 1.678 | 0.014* |
| | | | Post | 1.036 | .081 | .858 | 1.214 | |
| | CL group | Tooth position | Pre | 17.791 | .982 | 15.631 | 19.952 | 0.237 |
| | | | Post | 19.978 | 1.500 | 16.678 | 23.279 | |
| | | Palatal bone position | Pre | 14.235 | .863 | 12.336 | 16.134 | 0.484 |
| | | | Post | 15.460 | 1.436 | 12.301 | 18.620 | |
| | | Buccal bone position | Pre | 23.156 | .943 | 21.080 | 25.232 | 0.668 |
| | | | Post | 23.908 | 1.605 | 20.375 | 27.441 | |
| | | Cortical thickness | Pre | 1.614 | .207 | 1.158 | 2.070 | 0.049* |
| | | | Post | 1.103 | .080 | .928 | 1.279 | |

- **1st molar measurements:** there was a statistically non- significant increase in the 'tooth position' and 'palatal bone position' measurements. The 'buccal bone position' and the 'cortical thickness' measurements decreased non- significantly. (table 6)

**Table (6): comparison between the pre and post alignment CBCT 1st molar measurements within the SL and CL groups using ANOVA for repeated measures.**

| tooth | side | measurement | time | Mean | Std. Error | 95% Confidence Interval | | P value |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound | |
| 1st molar | SL Group | Tooth position | Pre | 19.860 | .517 | 18.723 | 20.997 | 0.496 |
| | | | Post | 18.595 | 1.468 | 15.363 | 21.827 | |
| | | Palatal bone position | Pre | 15.426 | .597 | 14.111 | 16.740 | 0.398 |
| | | | Post | 14.115 | 1.129 | 11.630 | 16.600 | |
| | | Buccal bone position | Pre | 25.419 | .578 | 24.146 | 26.691 | 0.572 |
| | | | Post | 24.338 | 1.522 | 20.988 | 27.689 | |
| | | Cortical thickness | Pre | 1.425 | .119 | 1.164 | 1.687 | 0.867 |
| | | | Post | 1.445 | .124 | 1.171 | 1.719 | |
| | CL group | Tooth position | Pre | 20.801 | .887 | 18.849 | 22.753 | 0.524 |
| | | | Post | 21.851 | 1.372 | 18.830 | 24.872 | |
| | | Palatal bone position | Pre | 16.062 | .856 | 14.178 | 17.945 | 0.729 |
| | | | Post | 16.668 | 1.394 | 13.601 | 19.736 | |
| | | Buccal bone position | Pre | 26.154 | .981 | 23.995 | 28.313 | 0.509 |
| | | | Post | 27.283 | 1.504 | 23.974 | 30.593 | |
| | | Cortical thickness | Pre | 4.617 | .636 | 3.216 | 6.017 | 0.628 |
| | | | Post | 4.394 | .110 | .375 | .857 | |

Comparison between the mean changes (pre alignment and post alignment) measurements at the canine, premolar and molar regions between the groups (the SL side and the CL side) in both maxilla and mandible:

- **Canines, 2nd premolar and 1st molars measurements:** there was no statistically significant difference between the two groups in any of the measurements of all the teeth assessed. Both systems produced an insignificant increase in the 'tooth position' and the 'palatal bone position' and an insignificant decrease in the 'buccal bone position' and the 'buccal cortical thickness' of all the teeth. The results indicated that both systems produced expansion by tipping movement without any buccal bone formation. (Tables 7, 8&9).

**Table (7): Comparison between the canine CBCT measurements between the SL and CL groups using Wilcoxon signed rank test :**

| Post- Pre | SL Side | | CL Side | | P value |
|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | |
| Canine position | 0.8 | 4.16 | 1.79 | 3.35 | 0.218 |
| Palatal bone position | 1.66 | 3.24 | 1.01 | 2.28 | 0.808 |
| Buccal bone position | -1.1 | 2.89 | -1.135 | 2.56 | 0.989 |
| Cortical thickness | -0.16 | 0.65 | -0.24 | 0.44 | 0.391 |

**Table (8): Comparison between the 2nd premolars CBCT measurements between the SL and CL groups using Wilcoxon signed rank test:**

| Post- Pre | SL Side | | CL Side | | P value |
|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | |
| 2nd premolar position | 0.93 | 2.96 | 0.71 | 3.16 | 0.563 |
| Palatal bone position | 0.06 | 1.85 | 0.07 | 1.81 | 0.726 |

| | | | | | |
|---|---|---|---|---|---|
| Buccal bone position | -0.41 | 2.48 | -0.13 | 2.32 | 0.619 |
| Cortical thickness | -0.26 | 0.73 | -0.48 | 1.14 | 0.809 |

**Table (9): Comparison between the 1st molars CBCT measurements between the SL and CL groups using Wilcoxon signed rank test:**

| Post- Pre | SL Side | | CL Side | | P value |
|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | |
| 1st molar position | 0.38 | 2.15 | 0.16 | 1.91 | 0.146 |
| Palatal bone position | 0.64 | 1.89 | 0.03 | 1.82 | 0.15 |
| Buccal bone position | -0.06 | 1.81 | -0.44 | 2.01 | 0.353 |
| Cortical thickness | -0.07 | 0.54 | -0.07 | 1.13 | 0.737 |

## IV. Discussion

Bracket designs have undergone several modifications since fixed appliances were first introduced in orthodontics, aiming to improve their clinical efficiency. Recently, the promotion of SL brackets had incited much controversy. SL brackets are claimed to provide low friction combined with light forces thus enhancing the rate of tooth movement and decreasing the overall treatment time[16]. Other advantages include decreased appointment times, improved oral hygiene, increased patient acceptance due to less need for extraction, bone expansion and bodily movement and superior treatment results [17, 18]

Most of the facts about SL systems are withdrawn from in-vitro studies [16, 19- 22]. Systematic reviews have been published to highlight the limitations of such studies [13, 23]. The only significant advantages of SL systems over the CL ones that appeared to be supported by current evidence are shortened chairside time and $1.5^0$less incisor proclination [13, 23]. Therefore, the claims that self-ligating brackets facilitate greater and more physiologic arch expansion and, therefore, allow more non-extraction treatment options require more evidence.[16, 19]The fact is that excessive expansion can force the teeth through the cortical plate [24], ultimately causing bone dehiscence, and gingival recession [25].

Accordingly, some clinical studies investigated how far these claims are true. Fleming et al measured the transverse arch dimensional and incisor inclination changes using casts and lateral cephalograms and found them to be the same in both CL and SL systems following the alignment phase. [26]. Scott et al [14] measured the intercanine (ICW) and intermolar (IMW) widths changes in extraction patients. The author attributed the increase in the ICW found the canine being moved and retracted to a wider area in the arch, while sliding of the molars forward into a narrower part of the arch decreased the IMW.

The few studies addressing the bone expansion issue were conducted on non-extraction cases [12, 26]. Studies conducted on extraction cases investigated the effect of the SL systems on other parameters other than their true effect on the surrounding alveolar bone. Those parameters included rate of en-masse retraction [27], rate of passive extraction space closure [28], rate of canine retraction[29], and transverse arch dimensions[14]. No advantages of the SL systems over the CL ones were observed in any of those studies. Burrow[29] pointed out that the SL systems do not offer any advantage in the reduction of teeth retraction into the extraction spaces and attributed this to the 'binding' phenomenon. The effect of these systems on the alveolar bone remodeling in extraction cases is still lacking in the orthodontic literature. Thus In the current study, the criteria of selection of severe crowding necessitating extraction were chosen to better assess the efficiency of alignment with space available rather than alignment by flaring, minimizing any dehiscence or fenestrations. Another contemporary notion in the medical field is the interdisciplinary awareness. That is to say even if expansion is evident using SL brackets; what is this expansion's effect on the peridontium, namely the alveolar bone? If it is physiologic as the SL bracket companies claim then there should be no fenestrations or decrease in any of the bone thickness post treatment, on the contrary, it should be a regenerative process where the alveolar bone is more thick post treatment.In the current study, most cases were selected such that extraction of the premolars will just allow the high canines to descend in place with relief of anterior crowding, leaving no extra spaces remaining. Furthermore, a split mouth technique was adopted aiming at standardization of all variables as patient cooperation, oral hygiene, bone thickness and rate of tooth movement. Ong et al [28] measured the alignment efficiency and rate of extraction space closure in SL and CL groups pointing out to the postulation that the SL systems provide advantages in extraction cases during alignment and space closure [8, 9] . Other studies also compared both systems in extraction cases during en- masse retraction [27] and initial mandibular alignment[14] but no credits for SL systems were found. None of these studies assessed type of tooth movement obtained and bone contours using an accurate imaging modality. The conventional examination techniques of the alveolar bone (clinical, periapical, CT) did not prove to be very accurate or practical [30, 31, 32]. With the introduction of CBCT technology, both of the draw backs of dental radiographs (mediocre accuracy, limited visualization) and CT (high radiation dose) were overcame. Moreover, the 3D visualization gives the CBCT even an extra value.

The results of our study showed that both systems caused buccal tipping of teeth despite the extraction of the first premolars. There was a decrease in the buccal cortical thickness of canines, second premolars and

molars after the leveling and alignment phase in the SL group indicating that neither bodily movement nor expansion with newly formed bone has occurred as claimed. The results were clinically and statistically non-significant when the SL side was compared to the CL ones. In both groups, the leveling and alignment process caused a buccal tipping with a decrease in the buccal cortical thickness of the canines, premolars and molars. Expansion in both sides thus seems to be irrelevant to the type of appliance used. These results are very much similar to those of Kortam[(12)] who measured buccal bone height and thickness in posterior teeth of 45 non extraction cases using their CBCT's. The mean changes of buccal bone height and thickness measured were not significantly different between SL and CL groups. The author claimed that the change in bone height depended on the initial bone thickness where the greater the initial bone thickness, the less the decrease in bone height and came out to a conclusion that arch expansion and molar angulation can be similarly controlled by either type of appliance. The results of the current study agree with that of Kortam's study [(12)]keeping in mind that a split-mouth design was used in our research while the aforementioned study was performed on different subjects divided into two groups.

Another study by Cattaneo et al [(26)] compared between active and passive SL brackets in non-extraction cases and assessed the transverse tooth movements and buccal bone modelling obtained in maxillary lateral segments using CBCT. Transversal expansion of the upper arch was achieved by buccal tipping in all but one patient in each group and no statistical significant difference in inter-premolar bucco-lingual inclination was found between the two groups from T0 to T1. The authors finally concluded that buccal bone modeling using active or passive SL brackets could not be confirmed.

Both SL and CL systems caused buccal tipping of teeth and the cortical thickness surrounding each measured tooth was decreased, hence, the claims about expansion and bodily movement of teeth need to be revised.

## V. Conclusions

Actual alveolar bone expansion was not evident with the use of self ligating brackets in this study. Both self ligating and conventional bracket designs produced tipping tooth movement. Therefore, the use of SL bracket system offered no advantage over the CL ones in extraction cases regarding both alveolar bone thickness and type of tooth movement.

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