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# A prospective randomized clinical study comparing the alignment efficiency of four different ligation methods

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ABSTRACT

**Aim and Objective:** To conduct a prospective randomized study comparing the efficiency of four different ligation systems (ELL,SSL,LL,PSL) over the duration of mandibular crowding alleviation.
**Materials and Methods:** The study was conducted in Department of Orthodontics and Dentofacial Orthopaedics, Noorul Islam College of Dental Sciences, Neyyattinkara, Trivandrum. The present study evaluated the variations in alignment efficiency of four different ligation systems over the duration of mandibular crowding alleviation in patients during mandibular crowding alleviation. Eighty patients fulfilling the inclusion criteria were selected and equally divided into four groups- Elastomeric ligation (ELL), Stainless steel Ligation (SSL)- active and passive , Leone slide Ligatures (LL).
**Conclusion**: The mean treatment time for alignment for passive self ligating group (102 days) followed by leone group (128 days), stainless steel (176 days) and elastomeric (224 days) group. Thus the study showed no significant difference in the clinical performance between coventional, self ligating, while PSL performed significantly superior to other groups. From the above equation, during initial phase of orthodontic treatment.self-ligating brackets were more efficient than conventional brackets in anterior alignment, passive space closure, and mandibular incisal inclination.



## 1. Introduction

A efficient treatment mechanics is necessary to ensure good treatment results with less clinical time and shorter treatment duration.[1] The alignment of teeth is the first phase of fixed appliance therapy which differs with several variables. The tissue biology plays a vital role to the applied orthodontic force in periodontium which allows the tooth movement through alveolar bone.[2] The success of orthodontic tooth movement depends on Tooth vitality, cellular and connective tissue response and periodontial health. The choice of bracket system and archwire have a direct influence than these biological factors.[3]

The major factors determining the rate of tooth alignment in using pre adjusted edgewise brackets, include the bracket slot dimension, the inter-bracket distance,[4] the choice of archwire[5] and the frictional forces between bracket and archwire.[6] It is observed that 50% of applied orthodontic force is used to overcome the friction in the sliding mechanics.[1]

An ideal ligation system should have full bracket engagement and low friction between brackets and arch wire. Various self-ligating bracket systems have been developed to reduce unwanted friction,[7] SLB, Stolzenberg (1935) has two types of SL brackets Active and Passive.[8] With the light forces, they enhance the rate of tooth movement and reduces treatment time. Other advantages are decreased appointment times, improved oral hygiene,

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increased patient acceptance, and higher treatment results.[9]

To overcome some deficiencies of SL brackets, Leone slide ligature (LL) have been introduced. Leone slide ligatures (LL) with a polyurethane fourth wall allows the arch wire to slide freely in the slot and transmits its full force to the tooth.[10]

Many in-vivo studies have compared the efficiency of SL and CL brackets during various stages of treatment with different results.[11] These studies gave treatment efficiency in terms of total treatment time, number of appointments, and tooth movement during initial alignment and active space closure. Early retrospective studies showed up to 6 months reduction in total treatment time and fewer appointments with SL brackets.[12] Other ealier studies reported no significant differences during initial alignment or active space closure with various SL and CL brackets.[13] Both bracket systems had alignment with a combination of dental arch expansion and lower incisor proclination.[3]

Hence, the purpose of this prospective randomized clinical trial was to compare the efficacy of 4 ligation methods (Elastomeric ligation (EL), Stainless steel ligation (SSL), Leone slide Ligation (LL), Passive self-ligation (PSL)) in aligning the mandibular anterior crowding of extraction cases undergoing fixed appliance therapy.

## 2. Materials and Methods

The study was conducted in Department of Orthodontics and Dentofacial Orthopaedics, Noorul Islam College of Dental Sciences, Neyyattinkara, Trivandrum. The present study evaluated the variations in alignment efficiency of four different ligation systems over the duration of mandibular crowding alleviation in patients during mandibular crowding alleviation.

### *2.1. Armamentarium*

1. Ormco(Mini 2000) –MBT slot .022x.028inches conventional brackets
2. 3M (unitek gemini) –MBT slot .022x.028 inches passive self ligation brackets
3. 3M Arch Wire
4. 3M Elastomeric ligature
5. 3M Stainless steel ligature
6. Leone slide ligature
7. OPG
8. Vernier Caliper Device
9. Study Models

### *2.2. Inclusion criteria*

1. Fully Erupted Mandibular Permanent Teeth.
2. Mandibular anterior crowding with moderate irregularity index (4-6).
3. Age 12-18yrs.
4. First premolar extraction cases.
5. No adjunct therapeutic intervention involving lip bumpers. maxillary expansion appliances or headgear.
6. Good oral hygiene and periodontal status.

### *2.3. Exclusion criteria*

1. Patients with no consecutive follow up.
2. History of any known systemic diseases especially diabetes, periodontal disease.
3. Age above 18 yrs.
4. Patients with poor oral hygiene.
5. Impacted or unerupted permanent teeth.
6. Fractured crown, restorations, Enamel Defects, Caries, Periodontal cases.
7. Patient taking Medication.

The participants and their parents or guardians were informed about the study, its implication and written consent was obtained from them. Eighty patients with the inclusion criteria were selected and equally divided into four groups-Elastomeric ligation (ELL), Stainless steel Ligation (SSL), Leone slide Ligatures (LL), Passive self-ligation (PSL) by using Lottery Method. Strap up was done with Ormco (Mini 2000), .022x.028 stainless steel brackets for conventional method and 3M(Unitek Gemini).022x.028 stainless steel brackets for passive self-ligating method. The archwire sequence for the groups was 0.014-inch, 0.016-inch, 0.018 inch, 16 x 22 NiTi, 19 x 25 NiTi. 19 x 25 Stainless steel working wire were in place for 1 month. The patients were reviewed every 4 weeks and the first arch wire was left in place until the teeth were passively engaged in all the bracket slots. To permit bracket engagement the archwires were occasionally ligated with elastomeric in figure ‘8’configuration in areas of marked irregularity. Mandibular dental casts and photographs were taken at initial appliance placement (To) and at the end of alignment (T1). To calculate irregularity index, study models were measured using Vernier caliper device.

### *2.4. Statistical analysis*

Since there were four groups and each group was having 20 items which were listed on the quantitative data, parametric test such as ANOVA was applied. Followed by post hoc test as the p-value lower than level of significance (5%). Pairwise t- test was applied to examine the reasons for difference in mean value. In addition to this, Karl Pearson Co- efficient of correlation was also applied to examine the relationship between the experiment groups.

## 3. Results & Discussion

The present study evaluated the variations in alignment efficiency of four different ligation systems (leone, SL, stainless steel, elastomeric) over the duration of mandibular

**Table 1:** Mean treatment time to alignment by ligation group

| | N | Mean | Std. Deviation | P value |
|---|---|---|---|---|
| Elastomeric | 20 | 224.950 | 8.7025 | |
| Leone | 20 | 128.700 | 4.3661 | |
| Stainless steel | 20 | 176.150 | 9.8155 | <0.001** |
| Passive self-ligating | 20 | 102.350 | 4.9765 | |
| Total | 80 | 158.038 | 47.6598 | |

**Table 2:** Mean irregularity index in study groups at T0

| | N | Mean | Std. Deviation | P value |
|---|---|---|---|---|
| Elastomeric | 20 | 4.265 | 0.2943 | |
| Leone | 20 | 4.430 | 0.3893 | |
| Stainless steel | 20 | 4.450 | 0.4371 | 0.031* |
| Passive self-ligating | 20 | 4.665 | 0.5133 | |
| Total | 80 | 4.453 | 0.4325 | |

**Table 3:** Pairwise Comparison of mean treatment time to alignment between ligation systems

| Ligation system | Mean difference | P value | 95% confidence interval | |
|---|---|---|---|---|
| | | | Lower bound | Upper bound |
| EL vs. Leone | 96.25* | .000 | 90.1472 | 102.3528 |
| EL vs. SS | 48.80* | .000 | 42.6972 | 54.9028 |
| EL vs. PSL | 122.60* | .000 | 116.4972 | 128.7028 |
| Leone vs. EL | -96.25* | .000 | -102.3528 | -90.1472 |
| Leone vs. SS | -47.45* | .000 | -53.5528 | -41.3472 |
| Leone vs. PSL | 26.35* | .000 | 20.2472 | 32.4528 |
| SS vs. EL | -48.80* | .000 | -54.9028 | -42.6972 |
| SS vs. Leone | 47.45* | .000 | 41.3472 | 53.5528 |
| SS vs. PSL | 73.80* | .000 | 67.6972 | 79.9028 |
| PSL vs. EL | -122.60* | .000 | -128.7028 | -116.4972 |
| PSL vs. Leone | -26.35* | .000 | -32.4528 | -20.2472 |
| PSL vs. SS | -73.80* | .000 | -79.9028 | -67.6972 |

**Table 4:** Correlation between time to alignment and irregularity index using pearson correlation coefficient test

| | | Irregularity index | Time to alignment |
|---|---|---|---|
| Irregularity index | r value | 1 | -0.309** |
| | P value | | 0.005 |
| | N | 80 | 80 |
| Time to alignment | r value | -0.309** | 1 |
| | P value | 0.005 | |
| | N | 80 | 80 |

**. Correlation is significant at the 0.01 level (2-tailed).

**Table 5:** Association between irregularity index and groups with time to alignment using linear regression analysis

| ANOVA for multiple regression | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 103565.057 | 2 | 51782.529 | 52.547 | .000 |
| | Residual | 75879.830 | 77 | 985.452 | | |
| | Total | 179444.887 | 79 | | | |

**Table 6:**

| Coefficients | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model** | | **Unstandardized Coefficients** | | **Standardize Coefficients** | **t** | **Sig.** | **95.0% Confidence Interval for B** | |
| | | **B** | **Std. Error** | **Beta** | | | **Lower Bound** | **Upper Bound** |
| 1 | (Constant) | 273.022 | 36.733 | | 7.433 | .000 | 199.877 | 346.167 |
| | Irregularity index | -8.414 | 8.611 | -0.076 | -0.977 | .332 | -25.560 | 8.732 |
| | Groups | -31.008 | 3.310 | -0.732 | -9.367 | .000 | -37.600 | -24.417 |

Time to alignment = 273.022 – (8.414 x Irregularity index) – (31.008 x Ligation group)

crowding alleviation.

The participants and their parents or guardians were informed about the study, its implication and written consent was obtained from them. Eighty patients fulfilling the inclusion criteria were selected and equally divided into four groups- Elastomeric ligation (ELL), Stainless steel Ligation (SSL), Leone slide Ligatures (LL), Passive self-ligation (PSL) by using Lottery Method. Strap up was done with Ormco (Mini 2000), .022x.028 stainless steel brackets for conventional method and 3M(Unitek Gemini).022x.028 stainless steel brackets for passive self-ligating method. The archwire sequence for the groups was 0.014-inch, 0.016-inch, 0.018-inch, 0.016 × 0.022-inch Ni-Ti, 0.019 x 0.025 NiTi -inch. 19 x 25 Stainless steel working wire were in place for 1 month. The patients were reviewed every 4 weeks and the first arch wire was left in place until the teeth were passively engaged in all the bracket slots. To permit bracket engagemet the archwires were occasionally ligated with elastomeric in figure '8'configuration in areas of marked irregularity. Mandibular dental casts and photographs were taken at start of appliance placement (To) and at the end of alignment (T1). To calculate irregularity index, study models were measured using Vernier caliper device. Patients were recalled every month to change the modules and ligation.

In our present study from the Table 1, mean treatment time for alignment is compared between the ligation groups the passive self-ligating group had taken less time for alignment (102 days) followed by leone group (128 days), stainless steel (176 days) and elastomeric (224 days) group. Thus the results of present study shows that SL groups were more efficient than Conventional groups in alignment time. Gandini P et al[14] observed that SL systems and Leone slide ligatures on conventional brackets produce significantly lower frictional forces compared to other conventional ligatures.

Ong et al.[15] studied the effect of Damon 3MX SL brackets and 3M Unitek CL brackets for anterior arch alignment and passive space closure and found no significant difference between both the groups. Scott et al.[3] studied patients having mandibular first premolar extractions (RCT) and concluded Damon 3MX SL brackets were not effective than CL brackets during mandibular alignment.Ong et al., found that during initial alignment there is no change in the amount of passive space closure between the bracket systems.

In our present study from Table 2, comparison of irregularity index, passive self-ligating groups shows the highest mean value (4.665) followed by SS (4.45) followed by leone (4.43) and elastomeric (4.2) groups. Inspite of high irregularity index passive selfligating group took minimum number of days to completely align whereas elastomeric group took maximum number of days. The results shows that Conventional appliances relieve crowding more by incisal proclination while SL brackets relieve crowding by passive space closure. This property of SL brackets would help in preventing the torque loss during the initial alignment, prevent round tripping of the anterior teeth, thus minimizing root resorption and would minimize the net effective anchorage loss during the overall treatment time of an individual.

In our study from Table 3, the pairwise comparison of groups are highly significant suggesting there is difference between groups for mean time to alignment with self-ligating showing the minimum number of days for alignment.

In our study from Tables 4 and 5, pearson correlation coefficient r value of -0.309 there is weak negative correlation between the variables and is negative showing when one variable increases the other decreases. In our study when the ireegularity index increases the time to alignment decreases. Linear regression analysis shows the association between irregularity index and time for alignment. Both shows negative association which means when one increases the other decreases, the number indicates the number of time the one variable influences the other, thus arriving at an equation

Time to alignment = 273.022 – (8.414 x Irregularity index) – (31.008 x Ligation group)(i.e the irregularity index influence the time to alignment by 8.4 times)

## 4. Conclusion

The mean treatment time for alignment for passive self ligating group (102 days) followed by leone group (128 days), stainless steel (176 days) and elastomeric (224 days) group. Thus, the study showed no significant difference in

the clinical performance between coventional, self ligating, while PSL performed significantly superior to other groups. From the above equation, during initial phase of orthodontic treatment self-ligating brackets were more efficient than conventional brackets in anterior alignment, passive space closure, and mandibular incisal inclination

## 5. Conflict of Interest

There are no conflicts of interest in this article.


## 6. Source of Funding

None.


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