Introduction

With the evolution of orthodontic techniques, the MBT philosophy has gained substantial popularity over a long period of time. It has proved in achieving excellent force levels and resulting in tooth movement with optimum control during space closure of extraction sites [1,2]. There are different methods of space closing used for MBT technique. One of the method advocated is the use of active tieback taking help of elastomeric modules. 0.010 ''stainless steel ligature wire is used along with elastomeric module for active tieback.

Ideally the elastomeric module is meant for the purpose of arch wire ligation, but this technique advocates its use for the purpose of space closure. The amount of force exerted by the module is one of the important factors in successful space closure which in turn depends on the elastic properties of the module. Hence it is necessary for us to know the force degradation of the elastic module from the time of initial loading through its continual use between appointments. Incorrect force level can cause difficulty in space closing. Forces above the recommended level can cause tipping and friction and thus prevent space closing. Inadequate force may cause slower or no space closure in adults. The force levels also need to be in balance with the arch wire stiffness, or may cause arch wire deflection. Modules available with different commercial brands may exert different amount of force.

Hence the aim of this study is to compare the force degradation of four commercially available elastomeric modules in clinical application when used as an active tieback, in an invitro condition.

Material and Method

The prospective study was completed to test the force decay of the elastomeric module in an artificial saliva medium using modules available from different commercial brands commercially available ligature modules were selected from four different brands (American orthodontics, ORMCO, 3M, Jaipur orthodontics by liberaltraders'pvt.Ltd.). Twenty samples from each company were selected. 4 jigs each with a series of pins placed 28 mm apart were used in order to hold the stretched elastomeric modules.

These modules were stretched in the form of an active tieback using 0.010 inch SS ligature wire. The module was engaged in one pin and stretched to double the distance (as advocated by the MBT philosophy) using the ligature wire and tied to the opposite pin. These jigs were placed in an artificial saliva solution throughout the test period in order to provide an artificial oral environment at room temperature.

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Six test measurements of remaining force were made at the following time intervals: initial (0), 1, 7, 14, 21, and 28 days. Force measurements were obtained with a digital force tester by a single, blinded examiner. Prior to the initiation of the study, the force tester was calibrated by measuring the weight of known items, to ensure the reliability of the instrument. After each measurement the force tester was reset to a zero reading before taking the next measurement. During force measurement, the jigs were securely bound to a bench top using a vice clamp.

Measurements were made by leaving one end of the elastomeric chain secured on the pin and fixing the other to the force tester, allowing for the measurement of the tensile force (Figure 2). Measurement readings were taken with the elastomeric chain stretched to the same double the distance, that the jig pins had previously maintained them.

**Results**

Statistically significant effects of time on force decay were seen in all groups. The force decay is comparatively more in first 24 hours in relation to the initial loading force.

The initial loading force was observed highest in 3 M (515.50 grams) followed by ORMCO (472.15), liberal (463.98), American orthodontics (448.75).

But the standard deviation value is least with American orthodontics (21.9) as compared to ORMCO (35.6), 3M (45.3), liberal (78.3), which shows that the intergroup consistency of force exerted is more with American orthodontics. On the other hand it is very less with liberal with standard deviation of 78.3%.

The maximum force decay percentage within first 24 hrs. Was seen in ORMCO (46.1%).

Minimum force decay at the end of 28 days is seen in 3M (47.87%) followed by liberal (52.4%), then American orthodontics (54.94%) and then ORMCO (66.22%).

**Discussion**

The force decay of the elastomeric ligatures significantly altered the magnitude of the unloading forces.

The result of this study demonstrate that there is a significant force decay over a period of 28 days or till the time in between appointments. The results also confirm previous study [3, 4, 5-9] that the force decay is high initially and then reduce over time. For all the groups there is substantial amount of force decay in first 24 hours.

Amongst the four groups American orthodontics showed least force decay in first 24 hours (24.7%) followed by liberal traders (28.2%) , then 3M (31.9%) and then ORMCO (46.0%).

MBT philosophy advocates using elastomeric modules in the form of active tieback. They are stretched double the distance. Thus it becomes important that the module exert approximately equal amount of force when used

Bilaterally and also the amount of force decay plays an important role [2]. For effective tooth movement it is important that the module exert substantial amount of force throughout the appointment interval. In this relation, modules from 3M showed least force decay at the end of 28 days. Also the force exerted by modules with 3M showed highest force at the time of loading and also highest force at the end of 28 days. Although this study illustrates that time has statistical significant effect on the force decay of elastomeric module in vitro, but its effect in clinical situation is still inconclusive. The length to which the module is stretched, the interval between
Table 1: Comparison of force degradation using ANOVA test (American orthodontics)

(p < 0.05 - Significant*, p < 0.001 - Highly significant**)

| Force degradation | Number | Mean (SD) | % decay |
|-------------------|--------|-----------|---------|
| Loading           | 20     | 448.75 (21.9) | -       |
| 24 hours          | 20     | 337.50 (45.2) | 24.7%   |
| 7 days            | 20     | 285.75 (71.4) | 36.3%   |
| 14 days           | 20     | 248.50 (33.7) | 45.2%   |
| 21 days           | 20     | 202.25 (58.3) | 54.9%   |
| F value           | -      | 74.418     | -       |
| P value           | -      | <0.001**   | -       |

Table 2: Comparison of force degradation using ANOVA test (3M)

(p < 0.05 - Significant*, p < 0.001 - Highly significant**)

| Force degradation | Number | Mean (SD) | % decay |
|-------------------|--------|-----------|---------|
| Loading           | 20     | 515.50 (45.3) | -       |
| 24 hours          | 20     | 351 (44.0) | 31.9%   |
| 7 days            | 20     | 330.50 (66.1) | 34.1%   |
| 14 days           | 20     | 296.50 (38.0) | 42.4%   |
| 21 days           | 20     | 268.75 (47.8) | 47.8%   |
| F value           | -      | 84.752     | -       |
| P value           | -      | <0.001**   | -       |
### Table 3: Comparison of force degradation using ANOVA test (ORMCO)

| Force degradation | Number | Mean (SD)  | % decay |
|-------------------|--------|------------|---------|
| Loading           | 20     | 472.15 (35.6) | -       |
| 24 hours          | 20     | 254.50 (43.0) | 46.0%   |
| 7 days            | 20     | 218.25 (45.1) | 53.7%   |
| 14 days           | 20     | 173.75 (28.2) | 63.4%   |
| 21 days           | 20     | 159.50 (33.6) | 66.2%   |

| F value | 227.304 |
|---------|---------|
| P value | <0.001**|

### Table 4: Comparison of force degradation using ANOVA test (Libral traders)

| Force degradation | Number | Mean (SD)  | % decay |
|-------------------|--------|------------|---------|
| Loading           | 17     | 463.94 (78.3) | -       |
| 24 hours          | 17     | 332.94 (40.3) | 28.2%   |
| 7 days            | 17     | 285.59 (23.3) | 38.4%   |
| 14 days           | 17     | 239.12 (35.2) | 48.4%   |
| 21 days           | 17     | 220.88 (29.9) | 52.3%   |

| F value | 76.845 |
|---------|--------|
| P value | <0.001**|

Comparison of all the materials with amount of force exerted and time period.
appointments, and also the form and amount of tooth movement.

**Conclusions**

- Increase in force decay is seen with elastomeric module over time.
- Force decay in first 24 hours was seen minimum in American orthodontics.
- The range of force exertion at the time of loading was around 450 grams to 520 grams.
- 50 – 65% of force decay was seen in all the four groups.

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