Original Research Paper

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Evaluation of Post Treatment Stability with MBT System Versus Passive Self Ligating System in Non-extraction Cases: Analytical Observational Study

Abstract:

Objectives: To compare and evaluate the post treatment stability with respect to intercanine width, inter molar width, arch length, overjet and overbite in the maxillary and mandibular arches treated with MBT system and passive self-ligating system-Damonin non extraction cases.

Materials and method: This clinical prospective study was conducted on forty-four subjects who were treated for class I malocclusion with non-extraction treatment plan using fixed orthodontic appliances. They were equally divided into two groups: Group 1 MBT system and Group 2 –Passive self-ligating system. Immediately after debonding(T0), impressions were taken and casts were fabricated. Essix retainer was given in the maxillary arch, FLR was given in the mandibular arch from canine to canine. Subjects was followed up for one year(T1). The obtained casts at T0 and T1 were scanned with intraoral scanner and measured for intercanine width, intermolar width, arch length, overjet and overbite.

Results: Within the group and between the groups, both systems showed that ICW, IMW, arch length, overjet decreased and overbite increased from T0 to T1 which was not statistically significant differences indicating that both systems are capable of maintaining treatment outcomes effectively, with minimal relapse.

Conclusion: Both MBT and passive self-ligating systems shows comparable post-treatment stability. The observed changes were minimal and largely within clinically acceptable limits, suggesting that appliance selection for a case should be based on case-specific considerations and clinical requirements rather than expectations of superior stability, as the findings of this study reinforces the concept that stability is influenced by physiological limit, biomechanics of the appliance system, biological adaptation and retention protocols.

Keywords: .....

Introduction:

Long-term stability continues to represent one of the most complex and unpredictable aspects of orthodontic treatment. While contemporary fixed appliance therapy allows clinicians to routinely achieve ideal alignment, optimal intercuspation, and acceptable facial esthetics, maintaining these outcomes over time remains challenging. Relapse may occur in the form of mandibular anterior crowding, reduction in intercanine width, loss of arch length, and changes in overjet or overbite.

Numerous longitudinal studies have demonstrated that post-retention changes can occur even in well-treated cases, indicating that orthodontic correction does not permanently override inherent biologic and environmental influences. Little, Riedel, and Årtun reported that mandibular incisor alignment frequently deteriorates over a 10–20-year period following retention, regardless of whether treatment involved extraction or non-extraction protocols.[1] These findings

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underscore that post-treatment stability is multifactorial, influenced by growth, soft tissue pressures, occlusal forces, periodontal remodelling, and the original malocclusion characteristics.

Among the various factors implicated in relapse, maintenance of transverse arch dimensions, particularly mandibular intercanine width, has been consistently emphasised. Expansion of intercanine width beyond the patient's inherent muscular equilibrium has been associated with a greater tendency toward relapse. Longitudinal investigations have suggested that increases in mandibular intercanine width achieved during treatment are often unstable in the long term.[2] In contrast, preserving the patient's original arch form and respecting physiologic boundaries appear to enhance stability. This has led to greater emphasis on individualized archwire forms and biomechanical control during treatment.

Building on Andrews' original research, McLaughlin, Bennett, and Trevisi introduced the MBT prescription, a third-generation pre-adjusted edgewise system designed to improve control of tip and torque expression.[3] The MBT system incorporates specific bracket prescriptions with modified torque values for anterior and posterior teeth, facilitating controlled tooth movement while maintaining arch form integrity. The philosophy emphasizes the use of light continuous forces, lacebacks, bendbacks, and anchorage control to minimize unwanted incisor proclination and arch expansion, aims to achieve functional occlusion without compromising long-term stability.

In contrast, passive self-ligating bracket systems were introduced with claims of reduced friction during sliding mechanics, broader arch development, and more physiologic expansion. Passive self-ligating-Damon brackets incorporate a sliding mechanism that converts the bracket into a tube when closed, minimising binding between the archwire and bracket slot. Advocates suggest that these systems facilitate transverse arch development through broader archwires and lighter forces, potentially enhancing stability without extractions.[4] Damon proposed that passive self-ligation allows for arch development within biologic limits while maintaining periodontal health and facial balance.[5]

However, the purported advantages of passive self-ligating systems over conventional pre-adjusted edgewise systems remain controversial. Systematic reviews and ranomised controlled clinical trials have reported no clinically significant differences between self-ligating and conventional bracket systems in terms of treatment efficiency, arch width changes, or stability outcomes.[6,7]

Particularly in non-extraction cases, where transverse development and arch coordination are primary treatment goals, the long-term stability of expansion achieved with different bracket systems warrants careful evaluation. Since both MBT and passive self-ligating systems aim to preserve or develop arch form while achieving functional occlusion, comparative assessment of post-treatment stability becomes clinically relevant.

A successful orthodontic outcome extends beyond achieving proper alignment at the time of debonding; it should also maintain stability over time to ensure long-term functional and esthetic results. Orthodontic relapse remains a common clinical concern, as teeth tend to return toward their original positions due to factors such as periodontal fiber memory, occlusal forces and neuromuscular influences. Therefore, evaluating the stability of treatment results after appliance removal is crucial to determine the true effectiveness of different orthodontic treatment modalities. In recent years, various bracket systems have been used to achieve alignment, but their influence on long-term stability of dental arches and occlusal relationships remains a topic of discussion. Hence, the present observational study aims to evaluate and compare post-treatment stability, measured by intercanine width, intermolar width, arch length, overjet, and overbite, in non-extraction cases treated with the MBT system and passive self-ligating system, followed up for one year.

Materials and Methods:

Post-treatment stability was assessed on 44 subjects who underwent fixed orthodontic therapy with non-extraction treatment plan divided into 2 groups: MBT system and passive self-ligating system. Equal number of samples was distributed randomly in each group in the ratio of 1:1, so as to avoid any unanticipated deviations from statistical assumptions which **fulfil sampling criteria with power of 91.01%.**

This study was conducted at Government dental college and research institute, Bangalore with thefollowing inclusion criteria.

1. Non-extraction cases.
2. Subjects willing to use essix retainer in the maxillary arch.
3. Subjects willing to use fixed lingual retainer in the mandibular arch.
4. Subjects having moderate crowding (Little's irregularity index of 4-6mm).
5. Subjects with full complement of permanent teeth.
6. Subjects with age group 18 to 35 years.

Exclusion criteria:

1. Missing or supernumerary teeth and prosthetic restoration.
2. Systemic disease, syndromes or skeletal dysgnathia, which require surgical intervention**.**
3. Subjects with poor compliance or oral hygiene which have led to early termination of the fixed orthodontic treatment.
4. Anterior cross bite.
5. Subjects with the history of previous orthodontic treatment.

Post treated cases with MBT system and damon system with above mentioned criteria were randomly divide into two groups, Zhermack Elite HD+ putty and light-body silicone impression materials were used to take impression of maxillary and mandibular arches after debonding (T0). Casts were fabricated with the orthokal dental material. **Essix retainer was given in the maxillary arch and Fixed lingual retainer was given in the mandibular arch from canine to canine. Shining 3D Aoralscan 3 intraoral scanner** was used to scan the casts after de-bonding (T0). After one year of follow up(T1), impressions were taken and casts were fabricated and casts were scanned at T1.3D Images of maxillary (fig 01) and mandibular arches(fig 02) were measured using **Direct Aligner Designer software by Graphy (version of 4.0.6.1)** for ICW-Distance between the cusp tips of canine, IMW-Distance between tips of mesiobuccal cusps of first molar teeth, Arch length-Measured from distal contact point of 16 to mesial contact point of 13 and from here to contact point between11,21 and continued to mesial contact point of 23 followed to distal contact point of 26, overbite(fig03)- Extent of vertical overlap of maxillary central incisors over the mandibular central incisorsand overjet(fig04)-Extent of horizontal overlap of maxillary central incisors over the mandibular central incisors at T0 and T1.

Collected data was subjected to Statistical analysis.

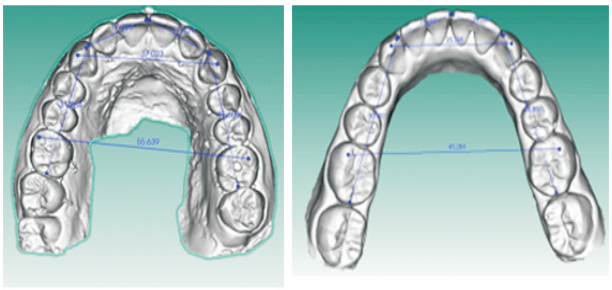

Fig 01-ICW, IMW, Arch length measured

Fig 02– ICW, IMW, Arch length on maxillary cast measured on mandibular cast.

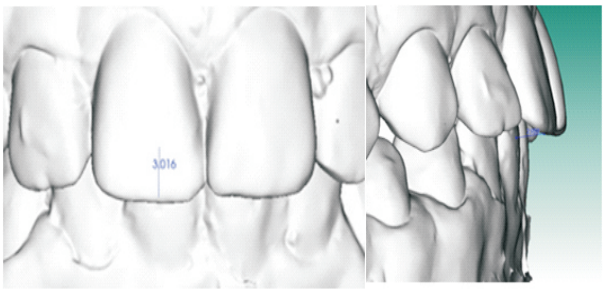

Fig 03- Overbite measurement Fig 04- Overjet measurement

Statistical Procedures:

Data obtained was compiled systematically in Microsoft Excel spreadsheet and a master table was prepared. The dataset was subdivided and distributed meaningfully. The data was presented as graphs and tables. Statistical analysis was performed using a personal computer with Statistical Package for Social Sciences software (SPSS version 20 IBM, USA). Depending upon the nature of the data, the statistical tests were chosen. Data was assessed for normality using Kolmogorov Smirnov test. Data was distributed normally. Descriptive statistics will be derived as mean, standard deviation and 95% confidence interval. Paired t test was used to compare T0 and T1 within group and Independent t-test was used to compare the data between groups. The level of significance is determined at p<=0.05.

Results:

Table 01 presentsthe intragroup changes from T0 to T1 with respect to intercanine width, intermolar width, arch length, overjet, and overbite in the maxillary and mandibular arches treated with the MBT system showing no statistically significant differences, suggesting stable treatment outcomes over time

	ICW		IMW		Arch Length		Overjet	Overbite
	Upper	Lower	Upper	Lower		Lower		
p Value	0.29	0.05	0.07	0.07	0.22	0.08	0.13	0.09
	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 01: Intragroup comparison from T0 to T1 in MBT group

Table 02, presents the intragroup changes from T0 to T1 with respect to intercanine width, intermolar width, arch length, overjet, and overbite in the maxillary and mandibular arches treated with the Damon system showing no statistically significant differences, indicating minimal and clinically acceptable changes over the follow-up period.

	ICW		IMW		Arch Length		Overjet	Overbite
	Upper	Lower	Upper	Lower		Lower		
p Value	0.09	0.08	0.06	0.10	0.06	0.10	0.05	0.06
	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 02: Intragroup comparison from T0 to T1 in passive self ligating group-Damon

Table 03, presents thedifferences in loss of retention between the MBT and Damon systems with respect to intercanine width, intermolar width, arch length, overjet, and overbite in the maxillary and mandibular arches showing no statistically significant differences, indicating that both systems exhibited similar post-treatment stability.

	ICW		IMW		Arch Length		Overjet	Overbite
	Upper	Lower	Upper	Lower		Lower		
p Value	0.91	0.74	0.21	0.60	0.58	0.98	0.97	0.36
Difference in loss of retention between groups	NS	NS	NS	NS	NS	NS	NS	NS

TABLE 03: Comparison of differences between two groups

Discussion:

Orthodontic treatment aims not only to achieve optimal alignment, functional occlusion, and facial aesthetics but also to ensure the long-term stability of these outcomes. Post-treatment stability is a critical objective in orthodontics, particularly in non-extraction cases where alignment is often achieved through dentoalveolar adaptation rather than space creation. However, maintaining post-treatment stability remains a significant clinical challenge, as relapse is a multifactorial phenomenon influenced by biological adaptation, treatment mechanics and retention protocols. In non-extraction cases, where space is often gained through dentoalveolar expansion and incisor proclination, the risk of instability may be further accentuated. [8,9]

The MBT system's bracket prescription is based on the Andrews' original research, that incorporate specific tip and torque values, allowing better control over tooth movement while preserving the existing arch form. It relies on light, continuous forces along with mechanics such as lacebacks, bendbacks, and proper anchorage control to limit unwanted incisor proclination and unnecessary arch expansion. By maintaining careful arch coordination and controlling transverse dimensions, the MBT approach aims to produce a functional occlusion without negatively affecting long-term stability.[10]

With the evolution of orthodontic appliances, passive self-ligating systems have been advocated to offer advantages such as reduced friction, enhanced arch development and light continuous forces thereby contributing to enhance stability when compared to conventional pre-adjusted edgewise systems like the MBT system[11]. Nevertheless, the evidence supporting these claims remains inconclusive, necessitating further investigation. Therefore, the present study evaluated and compared the stability of treatment outcomes between the MBT system and passive self-ligating system using parameters such as intercanine width (ICW), intermolar width (IMW), arch length, overjet and overbite. The findings demonstrated that both systems exhibited minimal changes between T0 and T1, indicating satisfactory post-treatment stability overall. These observations are consistent with established literature, which suggests that long-term stability is influenced more by biological factors and retention than by appliance design.[12]

MBT System:

The MBT system, based on pre-adjusted edgewise appliance mechanics, showed minor reductions from T0 to T1 in maxillary and mandibular ICW, IMW, arch length, overjet and slight increase in overbite. However, none of these changes were statistically significant. The slight dimensional changes observed may be attributed to post-treatment settling and physiological adaptation, rather than true relapse. These results are consistent with the work of Fleming et al. (2010), who reported that conventional ligation systems provide stable outcomes comparable to newer systems.[13]

Passive Self-Ligating System (Damon System):

The passive self-ligating system - Damon philosophy demonstrated similar stability patterns like MBT system from T0 to T1, with slight decrease in maxillary and mandibular ICW, IMW, arch length, overjet and slight increase in overbite which was not statistically significant. This finding supports the claims that Damon systems promote good stability with its treatment philosophy (Damon, 1998).[14]

Within the group treated with MBT system and passive self-ligating system indicated that all parameters remained almost stable from T0 to T1 in both groups, with no statistically significant differences. This suggests that both systems are capable of maintaining treatment outcomes effectively, with minimal relapse.

The evaluation and comparison of each parameter between the groups showed the following findings

Intercanine Width (ICW):

Intercanine width is a critical parameter influencing post-treatment stability, particularly in the mandibular arch. In the

present study, maxillary and mandibular ICW showed a slight reduction in both groups. These findings are in support with previous research indicating that mandibular intercanine width tends to return toward its original dimension over time.[8]However, these changes were statically not significant. These minimal changes observed suggest that transverse expansion was maintained within physiological limit, contributing to stability.

Intermolar Width (IMW):

Maxillary and mandibular intermolar width showed slight decrease in both groups, with no statistically significant differences observed. This indicates that posterior transverse dimensions achieved during treatment by both the systems were effectively maintained post-treatment. This supports the findings of Pandis et al. (2007), who reported that self-ligating systems do not produce significantly greater transverse expansion than conventional systems.[15]

Arch Length:

Arch length exhibited a slight reduction in both maxillary and mandibular arches across both groups, although these changes were not statistically significant. Such reductions can be attributed to post-treatment settling and occlusal adjustments, which are considered normal and expected physiological processes, as described by Bishara et al. (1994)[16]The similarity between groups indicates that both systems maintain arch length equally well post-treatment.

Overjet

Overjet analysis revealed slight decrease in both groups, although the changes were not statistically significant. This slight decrease in follow up period can be attributed to crowding alleviation by proclination during active treatment which is consistent with studies done by Ezgi et al (2017)[17]. It highlights the importance of careful control of incisor position and the need for effective retention strategies.

Overbite

Overbite increased slightly in both groups, although the changes were not statistically significant. This mild increase can be attributed to post-treatment settling, which often results in improved occlusal interdigitation.[9] The absence of significant differences between the groups indicates that vertical stability is maintained by both the bracket system used.

Between the two group comparisons, demonstrated no statistically significant differences in ICW, IMW, arch length, overjet or overbite. These findings indicate that both systems provide comparable post-treatment stability in non-extraction cases, which is consistent with systematic reviews in the literature.[18,19]

The absence of statistically significant differences in the evaluated parameters from T0 to T1 in both appliance systems may be explained by several factors.

Firstly, the treatment mechanics likely remained within physiological and biological limits, thereby minimizing undesirable tissue responses.

Secondly, the application of light continuous forces, along with effective torque expression in both the systems, may have facilitated optimal periodontal and soft tissue reorganization, contributing to post-treatment stability.

Finally, retention plays a critical role in preserving orthodontic results, the minimal relapse observed in both groups indicates that the retention protocols employed were effective, irrespective of the type of appliance used.

The findings of this study shows no statistically significant differences in each parameter for post treatment stability noted from T0 to T1 in both the systems for non-extraction cases over follow up period of one year. The observed changes were minimal and largely within clinically acceptable limits, suggesting that appliance selection for a case should be based on case-specific considerations and clinical requirements rather than expectations of superior stability, as the findings of this above study is reinforcing the concept that stability is influenced by physiological limit, biomechanics of the appliance system, biological adaptation and retention protocols.

Limitations

The present study has certain limitations that should be considered while interpreting the findings. The sample size was relatively small (n = 22 per group), which may limit the generalizability of the results. In addition, the follow-up period was short, restricting the ability to assess long-term relapse patterns. Retention compliance, which plays a crucial role in post-treatment stability, was not evaluated and may have influenced the outcomes. Furthermore, the absence of cephalometric analysis limited the assessment of dental changesof incisor positional variations. The observational study design may also introduce selection bias.

Moreover, cases with severe crowding were not included and extraction cases were not evaluated, which limits the

applicability of the findings to more complex malocclusions. Therefore, future studies with larger sample sizes, extended follow-up durations, randomized controlled designs, inclusion of severe crowding and extraction cases, and strategic retention compliance assessment are recommended to validate and strengthen these findings

Within the limitations of this study, both MBT and passive self-ligating systems demonstrated comparable post-treatment stability in non-extraction cases. The differences observed were minimal and not clinically significant.

Conclusion:

Within the limitations of the present study, it can be concluded that both the MBT system and passive self-ligating system demonstrate comparable post-treatment stability in non-extraction orthodontic cases. The changes observed in intercanine width, intermolar width, arch length, overjet and overbite were minimal and statistically not significant in both groups, indicating effective maintenance of treatment outcomes over the observation period.Therefore, the choice between MBT and passive self-ligating systems should be based oncase-specific considerations and clinical requirements rather than expectations of superior stability.

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