



Stability of Expansion Attained with Sel-ligating Bracket System

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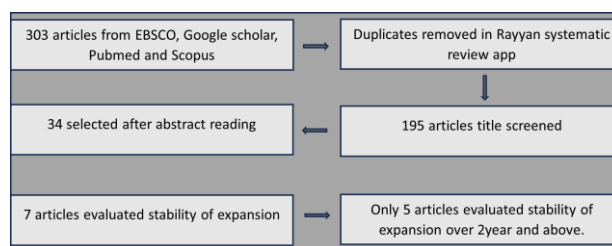
ABSTRACT:

Background: The Self-ligating system with in-built mechanism to secure the arch wire advocates comfort for the patient and clinician, reduces the chair side time and produces an expansion of the arch. Damon philosophy emphasises on light forces just enough to move teeth. The intra arch expansion is achieved by boarder arch wires, increasing the inter-canine, inter-premolar and inter-molar distance. The stability of the expansion achieved over the retention period determines the success of the treatment. For the clinician, it's a challenge to assert the merits for the self-ligating brackets as there are limited studies evaluating the stability of the transverse expansion achieved in both adults and adolescents. This literature review focuses on the transverse expansion achieved by self-ligating systems in the long term and to evaluate if there are any variations in the results achieved in adolescents and adults.

1. Introduction

Establishing aesthetics and function are the main aims of orthodontic treatment which are achieved by moving teeth into desired areas. A better smile to better life should be one of the goals in the orthodontic treatment. Developing new ideas and thoughts challenge the paradigm, that led to great achievements in scientific research. Self-ligating brackets claimed arch development, dental or skeletal expansion, permanent tooth extraction, or interproximal enamel reduction are the methods to achieve space for the orthodontic treatment.¹ Various designs of the brackets brought about increased efficiency in treatment and reduced the discomfort of both patient and clinician. Controlled expression of tip, torque, and rotation was possible by the dimensional changes in the arch wire. Later new developments in bracket design, lead to modifications in terms of slot, size, shape and position, the number of slots, the contour of the bracket and its base, as well as the mechanism for ligating the archwire to the bracket.

In recent years, self-ligating brackets have been widely



accepted at clinics due to a perceived increase in efficiency and orthodontic effectiveness. "Russel Lock" was introduced by Stolzenberg in 1935 but was not popularly used in clinical practise.² Later then on, other similar designs started to appear that included Ormco Edgelok (1972), Forestadent Mobil-Lock and Orec Speed (1980), Activa (1986), Time Lock bracket (1998), and the Damon 2 and In-Ovation brackets (2000). All of the designs can be broadly divided into two groups: conventional bracket system and self-ligating bracket system. The biological force is a term coined by Dr. Dwight Damon for orthodontic expansion, achieved through the low friction using passive brackets and



copper NiTi of low forces.³ Low friction in sliding mechanics, less contamination by the use of ligature wires or elastic modules and assumed low-magnitude forces resulting in fewer side effects and reduced soft tissue lacerations are the advantages of self-ligating system.⁴ The age and growth of a patient affect the treatment options and results of orthodontic treatment. Use of self-ligating or conventional brackets should be on the basis of age, growth and severity of malocclusion.

Though a lot of literature has been published comparing the efficacy of conventional and self-ligating brackets, long term follow up of patients treated with self-ligating brackets are few. There is no clear-cut view regarding mechanism of action or if the stability achieved varies according to age. With this in mind, it was decided to do a literature review of the stability achieved by self-ligating brackets.

2. METHODOLOGY

EBSCO, Google scholar, Pubmed and Scope database were used in the literature review and articles from 2001 to 2024 on transverse expansion using self-ligating bracket systems was reviewed. Three hundred and three articles collected from various database and after removing duplicates and title screening of 195 articles were done. keywords used for the search are self-ligating, transverse expansion, arch expansion, self-ligating bracket systems, Passive self-ligating ligating system and long-term stability. Out 195 articles, 34 for was selected after abstract reading (figure-1)). The transverse expansion of self-ligating was compared to conventional bracket system in most of the articles.

3. TYPES OF SELF-LIGATING BRACKETS

ACTIVE: A flexible part of an active self-ligating bracket keeps the arch wire in place. Active self-ligating bracket's pressure on the arch wire is by using a spring clip that enters the slot from the labial side. Its elastic component may also act as a potential energy storage medium while keeping the arch wire snug in its slot. Its soft touch exerts a steady yet mild push on the tooth and its surrounding tissues, allowing for regulated and precise motion. E.g., Fast, Innovative, Nexus, and Quick.⁵

PASSIVE: The passive brackets engage the arch wire by a stiff, moveable component. It has a vertical opening

and closing slide that does not intend to invade the slot and instead produces a passive labial surface. Because of this, tooth control is often jeopardized by using undersized wires stored in a structure that is effectively an arch wire tube.⁵ E.g., Vision, Carrier LX, Smart Clip, Praxis Glide and Damon

4. SELF-LIGATING BRACKET ADVANTAGES

The ideal self-ligating bracket should have the following properties

1. The bracket base should have appropriate curvature of the tooth which includes undercuts and retention.
2. Horizontal and vertical axis marks on the bracket
3. Easily identify the bracket for each tooth
4. The bracket should have hooks to engage elastics
5. Precise slot dimension
6. Ease of self-ligating mechanics and avoid accidental opening
7. Open and shut with little strain on the jaw and teeth.
8. Make it simple to engage and disengage the standard appliance accessories.
9. Able to engage elastics or elastics modules
10. Additional auxiliary slots.⁶

Although all self-ligating brackets have these benefits in theory, various brands have varying degrees of success in delivering them in reality. Harradine placed much emphasis on the clinically inconsequential savings of 24 seconds per archwire while using Damon SL for ligation and re-ligation and replacement.⁷ According to research by Majer et al., self-ligating procedures take just 14 minutes, whereas edgewise appliances need 21 minutes.⁸ Harradine et al compared each of the four self-ligating brackets (the Time, the SPEED, the Damon I, and the Twin Lock) to conventional concluded that these brackets had more efficient levelling, less friction, patient comfort, and little effort are only some of the therapeutic advantages of self-ligating systems.⁹

5. PROPOSED METHOD OF ACTION

The self-ligating system is very effective in correcting the malocclusions in the transverse plane without extractions, which is attained by incisor proclination and increase in the inter-canine width while being easy to use and comfortable for the patients.¹⁰ Passive self-ligating



appliances have low friction and active self-ligating can produce high torque expression, thus selection of the appliance varied according to the treatment requirements. As the arches widen, the intrinsic forces activate the biological forces that stimulate tongue and the tongue lifts and repositions itself more anteriorly.¹¹ Also after posterior dental arches expanded using Damon Archwires, both the patient's tongue height and length changed by 2.9 millimetres and 3.76 millimetres, respectively.¹² The increase in arch length led to more non extraction treatment options being available.

6. COMPARISON OF SELF-LIGATING BRACKETS

Self-ligating bracket systems when compared to conventional brackets, decreased treatment duration by an average of 4 months (from 23.5 to 19.4 months).¹³ Artun stated that altering the inter-canine width of retroclined incisors in the lower arch by proclination would give a successful result.¹⁴ Hass had suggested that inter-canine width remains stable if it's not altered beyond 3 to 4mm and up to inter-molar width of 6mm. The most serious problem that confronts patients who have undergone orthodontic treatment is the anterior malalignment especially mandibular incisors.¹⁵ A study by Gilmore and Little showed that only 6% of the crowding accounts for alteration of the width or the ratio of facio-lingual to the mesiodistal width of the incisors.¹⁶ Ribeiror et al evaluated EasyClip self-ligating and conventional preadjusted brackets, mandibular crowding was corrected but the time required to achieve correction was not statistically significant.¹⁷ Askari et al compared conventional appliance and Damon using CBCT scans of three individuals, traditional technique showed less proclination of lower incisors with expansion. CBCT showed arch expansion in both bracket system with further arch expansion with self-ligating appliances¹⁸

Bosse proposed that broader contact points and increasing available arch space can approximate the lower incisor position.¹⁹ Tecco et al compared fixed self-ligating and conventional straight-wire appliances used

to adjust the maxillary curve's sagittal and transverse components and found no significant differences in both in a year of orthodontic treatment.²⁰ Conventional and self-ligating brackets in the non-extraction patients had

no considerable change in the mandibular inter-molars distance with same wire sequence.²¹ The Cu-NiTi Archwires was used to correct moderate to severe crowding in passive self-ligating brackets and caused the dental arches to expand significantly, most noticeably in the premolar region of both jaws, resulting in a considerable increase in transverse width.²² Almeida et al did a CBCT study in self-ligating and conventional groups showed a substantial increase in mandibular length, as well as a reduction in mandibular buccal bone thickness and as well as transverse width of the buccal bone in²³ Calil et al assessed using CBCT the expansion with self-ligating bracket system and MARPE. There was a statistically significant reduction in buccal bone thickness and canine and premolar cross over development in the self-ligating group.²⁴ Using acrylic caps on the maxillary first molar teeth, for assessment of molar inclination, passive self-ligation was the same as active self-ligation or conventional brackets.²⁵

Akit et al research found that ICW decreased in both CB and SLB and inter premolar with Damon SL.²⁶ The studies by Verma et al and Palone et al were comparing the self-ligating brackets with the conventional bracket system and found to have expanded in both conventional and self-ligating system by increasing inter-canine and inter-molar width.^{24,27,28} McCauley recommended keeping the inter-canine and inter-molar distances as they were initially, in order to reduce retention issues. Whether growth affects the post treatment changes is controversial. Reidel stated that the growth aids in the correction of orthodontic problems.²⁹ The self-ligating studies were mostly in the mixed group of adult and adolescents and the stability was not correlated to either growth or age of the patients. There were also studies on adolescent population that achieved good expansion transversely and needed retention until an age of 18yrs. The retention appliance adds to the stability, but removable appliance produces jiggling forces that may compromise the healing and bone regeneration. Fixed retainers can serve as a periodontal splint. Bonded retainers were given initially for a period of 2 years and then replaced by the removable appliances.³⁰ The stability of upper teeth relies on the lower teeth and the first sign of relapse can be noted in the lower cuspid region.³¹ The post-retention stability of the arch improves with increasing time of retention protocol.



Author	Year	Methodology/ Self-ligation	Study population	Outcome
Palone et al	2021	Damon Q/multibracket	adolescents	Increased torque & transverse value
Marie et al	2020	Damon 2 bracket	Young adults	Increase in arch width
Mayona et al	2020	SL/ CB	adolescent & young adults	Except md ICW all increased
Calil et al	2020	MARPE/ Damon	Young adults	Damon-dental expansion, MARPE - skeletal expansion
Bashir et al	2019	Passive Smart clip active AO	Adolescents & young adults	Smart clip more expansion
Bharadwaj et al	2019	Damon 3MX	adolescents	Expansion & proclination both arches
Lima et al	2018	Damon/CB	Adult	Lower arch ICW and IMW greater than conventional
Maria et al	2018	Damon /Roth system	Adult & adolescent	No statistical significance thought ICW greater with Damon
Folco et al	2017	PSLS/ CB	Adult & adolescent	ICW, IPW increased
Almeida et al	2015	Easy clip / 3M Unitek	Adult & adolescent	Transverse expansion and proclination

Table I: - Comparison of self-ligating brackets with conventional brackets

7. LONG-TERM STABILITY

A study by Tynelius and Bondemark did assess mean inter-canine widths with showed that relapse was comparatively less while wearing the vacuum-formed retainer by 0.6–0.7 mm and wearing the positioner where it was reduced by 1.6 mm.³² The fibres within the periodontal membrane have a turnover rate of weeks, while remodelling of supragingival fibres take months.^{19,29} When it comes to periodontal issues, it has been shown that it takes at least 232 days for the tissues around the teeth to heal in their new location. The occlusal stability after a period of 4 years have shown that narrowing of the arch in adult populations and relative stable in the adolescent population.³³

Yu et al has found that bracket type did not matter in the adolescents and has long term stability with conventional as well as self-ligating brackets during follow up period of 7.24 years.³⁴ Basciftci et al analysed the treatment outcomes of Damon D3 MX bracket, protrusion of lower lip and exposure of the mandibular incisor was observed.³⁵ Also increased transverse diameters came with a significant positive torque gain, notably for the maxillary and mandibular premolars.³⁶ There are only two studies that evaluated the retention for more than 5 years Yu et al and Willet et al wherein the relative stability is seen after relapse within a year of treatment completion.^{37,38} Kaur et al compared the 2-year and 3-year retention protocol and evaluated after 3 years of

treatment. The summary of the long-term expansion is given in Table II. The stability of the treatment remained the same as the retention period increased.³⁹

Author	Year	Methodology/ Self-ligation	Study population	Follow up	Outcome
Willet et al	2022	Damon	Young adults	6years	Relative stable after 1year of treatment relapse
Kaur et al	2022	Damon Q	Late adolescent	2yrs	Without retainers ICW decreased
Verma et al	2021	PSLS/ CB	Young adults	1yrs	More relapse than conventional
Luchesse et al	2019	PSLS	Adolescents	2yrs	Transverse expansion with torque gain
Atk et al	2017	Damon / quad helix	Adolescent patients	3yrs	Reduction in ICW in both groups
Yu et al	2014	Comparison	Adolescent	7.24yrs (average)	No difference in the transverse expansion Adolescent group had longer stability.
Basciftci et al	2014	Damon 3 MX	adolescents	6 months	ICW reduced after 6 months of post-treatment

Table II- long term stability of self-ligating appliances

CONCLUSION

The studies have shown that there is a significant increase in inter canine, inter premolar, inter molar width when comparing the post treatment records of self-ligating systems with conventional bracket system. But the relapse of the achieved transverse expansion is seen in the inter-canine and inter-molar width. Most of the studies on the transverse expansion focused on the efficiency of the bracket system, but the long-term stability of the transverse expansion was not studied extensively. Among the self-ligating studies, the greatest number of studies was on Damon Self-ligating bracket system. The various mechanisms by which expansion is achieved has been put forward. All studies have shown that there is a significant reduction in the transverse expansion within a year of expansion. Also, the transverse expansion achieved in adult and adolescent population showed reduction in the expansion achieved after a year of expansion and maintained in the following years.

The studies showed the expansion in the self-ligating and conventional bracket was statistically similar in adolescents. Further studies need to focus on the stability of the transverse expansion obtained and determine if this is more in adolescents. There is a need for comparative studies on adults and adolescent population to evaluate the orthodontic expansion and if there is a difference in stability. Also, there has not been any evaluation to



compare the amount of crowding which can be corrected in adolescents and in adults.

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