

Comparison of self-ligating bracket and conventional bracket in orthodontic treatment: A systematic review

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Objective: Self-ligating brackets in orthodontics have been used over the last 30 years. These systems have been performed as the topic of several studies with good evidence making it likely to evaluate their efficacy and efficiency compared to conventional brackets. In this systematic review, we evaluated the differences between treatment efficiency, changes in transverse dimension, rate of canine retraction, treatment time and pain or discomfort in orthodontics.

Material and methods: Electronic databases (PubMed, Cochrane Library and ISI Web of Science) were investigated without language restriction. The related orthodontic journals and reference lists were proved for all eligible studies. Two article reviewers independently retrieved the data and evaluated the quality of the primary studies.

Results: A total of 132 articles were extracted in the initial search. However, only 23 articles met the inclusion criteria. Outcomes of treatment efficiency, changes in transverse dimension, rate of canine retraction, treatment time and pain or discomfort in orthodontics between two systems of bracket were clinically similar.

Conclusions: Based on existing evidence, self-ligating bracket could be proven no superior benefit than conventional bracket. No clinical approval can be made concerning the type of bracket systems.

Keyword: Efficacy, Friction, Orthodontics, Self-ligating brackets, Systematic review

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Introduction

An alternative to conventional pre-adjusted orthodontic brackets or self-ligating brackets have undergone more than 30 years. [1] Self-ligating brackets have attracted much attention in recent years and their use has increased substantially. Moreover, this has been claimed for more advantages over conventional brackets include: shorter treatment times, high rate of canine retraction

and improved patient comfort. However, the treatment efficiency and changes in transverse dimension of self-ligating brackets compared with conventional brackets have been shown in conflict evidence. [2, 3] Self-ligating brackets' information is still based on *in vitro* data, observational clinical data, or marketing claims. [1, 4-6] Although commercial and scientific interest has followed bracket developments, an insufficiency of clinical evidence exists.

In order to improve the understanding of bracket selection, clinical evidence would inform orthodontists and may impact to their decisions. The aim of the present systematic review is to compare between self-ligating and conventional brackets according to treatment efficiency, changes in transverse dimension, rate of canine retraction, overall treatment time and pain or discomfort of the patients.

Materials and methods

Search strategy

The PubMed, Cochrane library, and Web of Science electronic databases were searched for published literature from 2006 - August 2017 using the following keyword in all fields :(orthodontic) and (self ligating bracket or self-ligating or self-ligating appliance) and (conventional bracket or conventional appliance) and (friction or efficiency or canine retraction or treatment time or space closure or discomfort or pain) and (clinic*).

Data extraction

The studies were assessed for eligibility based on title and abstracts by two observers independently, disagreement was resolved by discussion until consensus was reached. Studies that were not related to the topic were excluded. All relevant publications with insufficient information were obtained in full text.

Data extraction tables were used to collect findings from included studies. Study design, information of participants, type of appliance, and outcome of each study were extracted.

The primary outcome of this review was treatment efficiency of self-ligating system. The secondary outcomes were changes of transverse dimension, rate of canine retraction, total treatment time and pain or discomfort of the patients.

Inclusion criteria

The trials that meet the following criteria were included

- Human studies
- The study was retrospective or prospective randomized controlled trial or controlled clinical trial
- The study investigated the treatment efficiency, change of transverse dimension, rate of canine retraction, total treatment time and pain or discomfort in patients treated with self-ligating brackets compared with conventional brackets.

Exclusion criteria

Studies with irrelevant study title or study design or study protocol, studies in laboratory or animal, previous systematic review.

Prisma Flow Chart

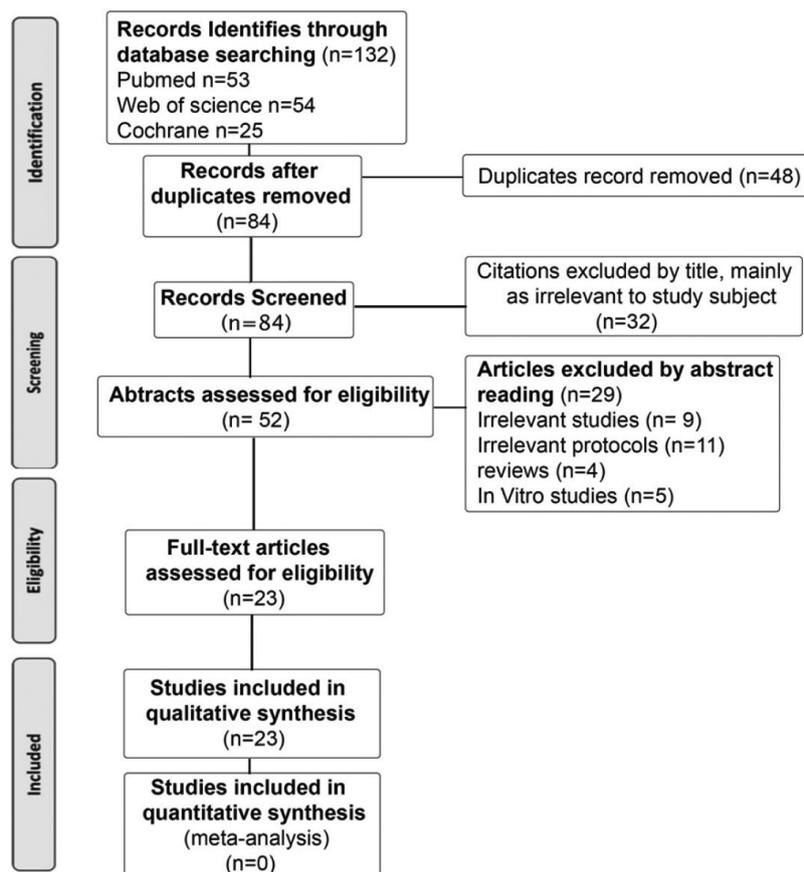


Figure 1 Prisma Flow Chart

Results

Study inclusion

Initial electronic search found 132 relevant publications. After duplicate citations were removed, 84 studies were screened by reading titles and abstracts and 29 studies were excluded. The 52 remaining articles were read in full text for eligibility according to inclusion criteria and finally 23 publications were included in this review. The details are shown in PRISMA flow chart.

Study characteristics

The information of included studies was described in Table 1. From all studies, 3 were clinical controlled trial (CCTs), 16 were randomized controlled trial (RCTs) and 4 were retrospective studies. In 3 CCTs, 2 CCTs used split-mouth design and another one used parallel group design. For 16 RCTs, 14 were parallel group design and 2 split-mouth designs. These studies focused on comparison of conventional brackets and self-ligating brackets in 5 main treatment outcomes which are treatment efficiency, change in transverse dimension, rate of canine retraction, total treatment time and pain or discomfort.

Table 1 Overview of included studies

Author/Year	Study Design	Number of patients	Appliances
Miles et al., 2006(2)	Prospective CCT, split mouth	58 subjects (40 females, 18 males, average age of 16.3 years)	Damon2 (ORMCO, Glendora, Calif) vs Conventional
Scott et al., 2008(7)	RCT, parallel groups	62 subjects (29 synthesis appliance and 33 Damon3)	Damon 3 vs conventional
Hamilton R., 2008(1)	Retrospective matched groups,	762 subjects (383 with pre-adjusted brackets and 379 active self-ligating brackets)	Active SL vs conventional
Rohaya et al., 2012(8)	RCT, parallel groups	29 subjects (10 males and 19 females)	Damon 3 vs conventional (Mini Diamond)
Johanssen and Lundstrom, 2012(9)	RCT, parallel groups	90 subjects (44 patients with SL and 46 patients with CE)	Time 2 SL vs conventional (Gemini brand, 3M)
Songra et al., 2014(10)	RCT, parallel groups	98 subjects (80 subjects self-ligating group and 18 conventional bracket group)	Active SL vs passive SL vs conventional
Anand M. et al., 2015(11)	Retrospective matched groups	108 subject (74 patients from clinician 1 and 34 patients from clinician 2)	SL (Damon Q) vs conventional (MiniUni-twin;3MUnitek,Victory)
Lian O'Dwyer et al., 2016(12)	Multi-center two-arm parallel RCT	135 subjects (mean age 14 years 11 months)	SL (3M SmartClip) vs conventiona (3M Victory)
Mevlut Celikoglu.,2015 (13)	Prospective RCT, parallel groups,	46 subjects (SL 22 patient ; 17 male & 5 female subjects; mean age, 15.48 ± 2.53 years and CL 24 patient ;16 male & 8 female subjects; mean age, 14.65 ± 2.02 years)	SmartClip vs conventional (Gemini brackets, 3M Unitek)
Ezgi Atik., 2014(3)	Prospective CCT, parallel groups,	33 subjects (17 patients with Roth (mean age of 14.5years) and 16 patients with Damon 3MX(mean age of 14.8years))	Damon3MX SL vs conventional plus quad helix
Burrow., 2010(14)	Prospective RCT, parallel groups, 43 subjects	43 patients, 21 Damon 3, 22 SmartClip, 43 Conventional Victory Series, Female 44%, Male 56%Mean age 14.8 ± 6.24 years	Damon 3 vs SmartClip vs conventional Brackets
M Mezomo.,2011(15)	Prospective RCT, split mouth, 15 subjects	15 patients, 10 female, 5 male, age 12-26 years, mean age 18 years	SmartClip vs conventional

Table 1 Overview of included studies (Con.)

Author/Year	Study Design	Number of patients	Appliances
Rohaya., 2013(16)	Prospective RCT, parallel groups, 20 subjects	20 patients, Age 14-30 years, 10 Damon 3, 10 Conventional	Damon 3 SL vs conventional (control anchorage with TPA)
da Costa Monini A., 2014(17)	Prospective RCT, split mouth, 25 subjects	25 patients, female 16, male 9, Mean age 23.32 ± 5.08 year, 13 right side, 12 left side	SL vs conventional
Pandis et al., 2007(18)	Prospective CCT, parallel groups, 54 subjects	54 patients, 20.37% M, 79.63% F (age 13.7 ± 1.38 years), 27 conventional (age 13.92 ± 1.43 years), 27 self-ligating (age 13.48 ± 1.31)	Damon 2 vs conventional
Fleming et al., 2010(19)	RCT, parallel groups, 54 subjects	54 patients, 26 conventional (7M 19F) mean age 15.48 ± 2.38 years, 28 SmartClip (11M 17F) mean age 16.11 ± 2.74 years,	SmartClip vs conventional (Victory)
DiBiase., 2011(20)	Prospective RCT, parallel groups	48 patients, 21 conventional mean age 16.38 ± 5.28, 27 Damon3 mean age 16.19 ± 3.68 years	Damon 3 vs conventional
Machibya., 2013(21)	Retrospective matched groups, 69 subjects	69 patients (21M, 48F) mean age 15.64 ± 3.74 years, 34 SmartClip (12M 22F) mean age 15.31 ± 3.39 years, 35 conventional (9M, 26 F) mean age 15.94 ± 4.04 years	SmartClip vs conventional (Victory)
Juneja., 2015(22)	Retrospective matched groups, 20 subjects	20 patients, 10 SmartClip mean age 17.8 ± 2.1 years, 10 conventional mean age 17.6 ± 2.1 years	SmartClip vs conventional (MBT)
Scott et al., 2008(23)	RCT, parallel groups, 62 subjects	60 patients (30 males, 30 females) mean age 16.3 years, 33 Damon 3, 29 conventional	Damon 3 vs conventional
Fleming et al., 2009(24)	prospective RCT, parallel groups, 66 subjects	48 patients, Age 11-21 years, 26 SmartClip mean age 16.23 ± 2.91 year, 22 conventional mean age 15.65 ± 2.1 year	SmartClip vs conventional (Victory)
Atik and Ciger., 2014(3)	RCT	33 female patients, 17 conventional mean age 14.5 ± 1.2 years, 16 self ligating mean age 14.8 ± 1.0 years	Damon 3 vs conventional
Rahman., 2016(25)	Two arm, multicenter, prospective RCT (Jan 2006 to Dec 2007), parallel groups	135 subjects, only 113 subjects return pain data (41 male, 72 female) mean age 14.9 ± 2.5 year, 60 conventional mean age 14.5 ± 1.9 years, 43 SmartClip mean age 15.4 ± 3.0 years	SmartClip vs conventional (Victory)

Table 2 : Effect of intervention

Table 2.1 Treatment efficiency

Author/Year	Outcomes	Finding
Miles et al., 2006(2)	Initial alignment of leveling phase at 10 and 20 wks show no pretreatment difference in the irregularity between the Damon 2 side and the conventional twin bracket side	No difference in the reducing irregularity of Damon 2 bracket and the conventional twin bracket with elastomeric ligation
Scott et al., 2008(7)	Rate of alignment of the Damon3 appliance system was no more clinically effective than a conventional ligated appliance during the alignment phase of orthodontic treatment	No difference in rate of alignment between self-ligating brackets and conventional brackets
Hamilton R., 2008(1)	Mean total treatment time in Group 1 (conventional, pre-adjusted brackets) is 15.8 months; Group 2 (self-ligating brackets), 15.5 months, number of appointments in Group 1, 13.2 visits and Group 2, 12.5 visits. Overall, there was no statistically significant difference between the durations of treatment. The treatment characteristics associated with prolonged treatment were: extraction of teeth, a Class II molar relationship and the degree of maxillary crowding or spacing.	No statically significant difference in total treatment time and number of appointment between 2 groups
Rohaya et al., 2012(8)	In the aligning stage, the patients were recalled at monthly interval for 4 months. The conventional brackets (Mini Diamond) group showed significantly faster alignment of the teeth compared with the self-ligating (DamonTM 3) group at the 1st and 2nd month. However, there were no differences at 3rd and 4th visit for either group. Alleviation of crowding was faster with conventional brackets than with self-ligating brackets.	Conventional brackets aligned the teeth faster than self-ligating brackets but only during the 1st month. There was no difference in efficacy between the 2 groups in the later 3 weeks.
Johanssen and Lundstrom, 2012(9)	In this prospective randomized trial, there were no statistically significant differences in treatment time, number of visits between self-ligating edgewise brackets (SL; Time2) and conventional edgewise brackets (CE; Gemini). The mean treatment time in months was 20.4 for the SL group and 18.2 for the CE group.	No difference in overall treatment time, number of visits between 2 groups.

Table 2.1 Treatment efficiency (Con.)

Author/Year	Outcomes	Finding
Songra et al., 2014(10)	Labial segment alignment and space closure were evaluated. This study demonstrated a statistically and clinically significant difference between the conventional and the 2 self-ligating brackets in the time to achieve initial alignment. Alignment was achieved more rapidly with the conventional Omni bracket, with no difference between the 2 self-ligating brackets.	Initial alignment was quicker with the conventional brackets and no difference between 2 self-ligating systems.
Anand M. et al., 2015(11)	Bracket system may not have a major effect on arch dimension, mandibular incisor inclinations, occlusal outcomes and treatment efficiency	No difference in arch dimension, mandibular incisor inclinations, occlusal outcomes and treatment efficiency
Lian O'Dwyer et al., 2016(12)	The mean treatment time was 25.12 months in the SmartClip group and 25.80 months in the Victory group. The difference of 0.68 months was not found to be statistically significant.	No difference between SmartClip self-ligating brackets and conventional Victory brackets regarding the number of visits and overall treatment time

Table 2.2 Transverse Dimension

Author/Year	Outcomes	Finding
Ezgi Atik., 2014(3)	The maxillary intercanine, interpremolar, and intermolar widths were significantly larger after the treatment in both appliance systems. However, when the level of expansion achieved between the two groups was compared, no significant difference was found.	No difference
Mevlut Cellikoglu., 2015(13)	Anterior irregularity index values significantly decreased up to 16 weeks in both the groups. Inter canine width significantly increased at 8 and 16 weeks in the self-ligating and conventional groups, but intermolar width did not change significantly. During 16 weeks of alignment, the mandibular incisors were significantly proclined, but their position did not significantly change in both groups.	No difference of effectiveness for initial mandibular alignment in SmartClip self-ligating and conventional brackets

Table 2.3 Canine Retraction

Author/Year	Outcomes	Finding
Burrow., 2010(14)	The rate of movement for conventional brackets per 28 days was 0.17 mm greater than self-ligating brackets, SmartClip faster than Damon3 which was statistically significant. Retraction rate is faster with conventional brackets, probably due to narrower width of self-ligating brackets	Retraction rate is statistically significant faster with conventional brackets
M Mezomo.,2011(15)	The total movement of the upper canines and first molars did not differ between self-ligating or conventional brackets but there was less rotation of upper canines with self-ligating brackets.	No difference in rate of canine retraction and anchorage loss between SLB and CB. Rotation of upper canine was minimized with SLB.
Rohaya., 2013(16)	Canine retraction was carried out on a round 0.018-inch stainless steel wire with NiTi closed coil spring at force of 150g. Transpalatal arch was used to stabilize molar position. The distance between tip of canine and mesiobuccal groove of upper first molar was used to assess the canine movement.	No difference
da Costa Monini A.,2014(17)	Canine crowns were retracted 0.71, 0.72 mm/month and apices were retracted 0.22, 0.24 mm/month for self-ligating and conventional groups. Molar were protracted 1.28mm in self-ligate group and 1.24 mm in conventional group. Total time for space closure was 10.86 months and 10.7 months for self-ligating and conventional groups, respectively.	No significant difference was found between two groups for all variables

Table 2.4 Total Treatment Time

Author/Year	Outcomes	Finding
Pandis et al., 2007(18)	Patients with moderate crowding (irregularity index 5) were finished 2.7 times faster than those treated with conventional brackets ($P .05$). Severe crowding showed a similar but less powerful tendency; treatment time was 1.37 times faster compared with conventional brackets, but this effect did not reach statistical significance.	No difference in time required for mandibular crowding correction between two groups.
Fleming et al., 2010(19)	The mean overall duration of orthodontic treatment was 19.92 months, 18.32 months in the conventional group and 21.41 months in the self-ligating group. A mean of 15.7 visits was required for conventional group, with 2 additional visits for the self-ligating group. There was no statistically significant association between the 2 bracket types on treatment duration or required visits	No difference in overall treatment time and number of visits were found between two groups
DiBiase., 2011(20)	the effect of the bracket system used on total duration of treatment and number of visits was not significant. In contrast, the duration of space closure had a significant effect on the duration of treatment but not on the number of visits. The effect of the bracket system on total PAR reduction was not significant.	No difference in overall treatment time, number of visits or occlusal outcome between two groups
Machibya., 2013(21)	Treatment time was 2.06 months reduction in self-ligating group but not statistically significant. There was significant mesial movement of first molars in both self-ligating and conventional brackets but the loss of anchorage between the two groups was not significantly different	No difference in overall treatment time between two groups.
Juneja., 2015(22)	Mean anchorage loss was 1.9 ± 0.68 mm and 2.08 ± 0.43 mm for SmartClip system and conventional system, respectively. Anchorage loss was reduced 0.18mm with self-ligating bracket but not statistically significant. Mean treatment time in self-ligating and conventional systems were 14.0 ± 2.4 months and 17.2 ± 2.6 mm. The mean difference in treatment time between two groups was 3.2 months which was statistically significant.	No difference in anchorage loss but SL is efficient in reducing overall treatment time

Table 2.5 Pain and Discomfort

Author/Year	Outcomes	Finding
Scott et al., 2008(23)	Discomfort from VAS score decreased with time for both appliances over the observation period. No significant difference in discomfort score between 4 and 24 hours, but at 24–72 and 72–168 hours, the scores were significantly different. Although there were no significant differences, mean discomfort of conventional group exhibit a lower level of discomfort than the Damon3, at all time periods.	No significant difference between the discomfort level for the two systems at any time interval.
Fleming et al., 2009(24)	Mean pain scores for conventional and self-ligating groups were higher at 24 hours and decreased over time. Bracket type had no effect on pain experience at 4 hours (P .958), 24 hours (P .289), 72 hours (P .569), and 7 days (P .756) following 0.019 x 0.025 NiTi archwire insertion and removal	Statistically significant difference in pain experience was found between two groups. Insertion and removal of rectangular archwire result in greater pain in SmartClip group.
Atik and Ciger., 2014(3)	Pain intensity decreased over time in both groups. During first month, the conventional and self-ligating groups showed the same pattern of changes in VAS scores.	No difference in pain intensity between two groups.
Rahman., 2016(25)	Self-ligating caused 0.174 of a pain unit more discomfort than conventional system. The discomfort of lips and cheeks was 0.167 of pain unit less than discomfort on teeth. Pain increase at day 1 after archwire changed and lesser on day 3 and much lesser on day 5.	No clinically significant difference was found between two groups. No serious harm was observed.

Treatment Efficiency

In 2006, Miles et al [2] compared the efficacy and comfort of Damon 2 brackets and conventional twin brackets during initial leveling. 58 patients joined in a split mouth design. One side of the lower arch was bonded with the Damon 2 brackets and the other with conventional twin brackets. At both archwire changes at 10 and 20 weeks, the conventional brackets had accomplished than the Damon 2 brackets by 0.2 mm, which is not clinically significant. The Damon 2 bracket was no better during initial leveling than a conventional bracket.

Scott et al. [7] in 2008 using 62 subjects to compare the effectiveness of mandibular tooth alignment and the clinical efficiency of a Damon3 self-ligating brackets and a Synthesis (Ormco) conventional pre-adjusted edgewise orthodontic bracket system. Results show no significant difference was noted ($P >0.05$) in early rate of alignment for either bracket system. Alignment was associated with an increase in intercanine width, a decrease in arch length, and proclination of the mandibular incisors for both systems, but the differences were not significant.

Another study in 2008 was from Hamilton R. [1] The study divided patients into 2 groups and compared the mean total treatment time. Results show that in group 1 (conventional, pre-adjusted brackets) was 15.8 months while group 2 (self-ligating brackets) was 15.5 months. Number of appointments in Group 1 was 13.2 visits and group 2 was 12.5 visits. In general, there was no statistically significant difference between the periods of treatment. The treatment characteristics related with prolonged treatment were extraction of teeth, a Class II molar relationship and the degree of maxillary crowding or spacing.

In 2012, Rohaya et al. [8] investigated the difference in clinical efficiency between DamonTM 3 self-ligating brackets (SLB) compared with Mini Diamond conventional ligating brackets

(CLB) during tooth alignment in straight wire fixed appliance therapy. The result showed no difference in efficacy between them in the later 3 weeks. Improvement of crowding correction was faster with CLB than with SLB.

Johansson and Lundstrom [9] conducted a prospective and randomized study of the efficiency of orthodontic treatment with self-ligating edgewise brackets (SL; Time2 brand, American Orthodontics) and conventional edgewise twin brackets (CE; Gemini brand, 3M) in 90 patients. The treatments were assessed in terms of total treatment time, number of appointments, and treatment outcome using the Index of Complexity, Outcome and Need (ICON). There were no statistically significant differences between the SL and CE groups in terms of average treatment time in months, average number of visits, mean ICON scores after treatment, or mean ICON improvement grade. The treatment with SL brackets does not decrease treatment period or number of visits and does not affect post-treatment ICON scores or ICON improvement grade compared with CE brackets.

Study of Songra et al (10) in 2014 compared the time to initial alignment and extraction space closure using conventional brackets and active and passive self-ligating brackets. All patients were treated with the identical archwire sequence and space-closing mechanics. The trial was a 3-arm parallel design. Labial-segment alignment and space closure were measured on study models taken every 12 weeks throughout treatment. They found that time to initial alignment was significantly shorter for the conventional bracket than for either the active or passive self-ligating brackets. And there was no statistically significant difference in passive, active, or total space-closure times among the 3 brackets under investigation.

Lian O'Dwyer et al [12] in 2016 used a two-arm parallel trial to compare treatment efficiency between a self-ligating (3M SmartClip) and a

conventional (3M Victory) pre-adjusted edgewise appliance system. Efficiency of each ligation system was evaluated by comparing the length of treatment (months) and total number of visits (scheduled and emergency visits). Results showed no clinically significant difference in treatment efficiency between both systems.

Transverse Dimension

Mevlut Celikoglu [13] examined the null hypothesis that SmartClip self-ligating brackets are more effective than conventional brackets for initial mandibular alignment and detected influential factors. The study conducted in fifty patients with self-ligating group (SmartClip brackets) and conventional group (Gemini brackets). The archwire sequence was standardized. Statistics of 46 patients were analyzed and shown that incisor inclination, intercanine width and intermolar width increased at 8 and 16 weeks in both the groups but no significant intergroup differences were noted. So, it can be concluded that bracket system has slight effect on improvement in anterior crowding during initial mandibular alignment.

In 2014, Ezgi Atik [3] evaluated two different treatment systems (Roth prescribed edgewise bracket and Damon 3MX) with regard to incisor position, transverse dimension changes in maxillary arch, changed in maxillary molar inclinations, clinical periodontal parameters, and pain intensity in 33 patients with a Class I malocclusion. Significant expansion of maxillary intercanine, interpremolar, and intermolar widths were shown in both systems. The conventional and Damon systems were found similar with regard to the incisor position, transverse dimension changes in maxillary arch, clinical periodontal parameters, and pain intensity. The only significant difference was that the Damon system expanded the maxillary molars more buccally than the conventional group.

Canine retraction

From the study of Burrow [14] in 2010, the rate of canine retraction was compared between the use of conventional brackets (Victory series) and self-ligating brackets (Damon3, SmartClip) in 43 patients, anchorage was controlled by transpalatal arch and canines were retracted by using retraction spring (150g) at 28-day intervals. The retraction rate in conventional bracket was statistically significant faster than self-ligating bracket which may result from narrower bracket width of the self-ligating bracket.

In 2011, Mezomo et al [15] found no difference between conventional (Gemini) and self-ligating bracket (SmartClip) in rates of canine retraction and anchorage loss. The study was carried out in 15 patients, random split-mouth design, canine retraction was done on 0.018-inch SS round archwires by using elastomeric chain (150g), first molar and second premolar were tied with SS ligature wire without additional anchorage. The amount of retraction was measured monthly and showed no difference in two bracket systems but self-ligating bracket provided better canine rotation control.

Rohaya et al [16], also compared the rates of canine retraction between self-ligating (Damon3) and conventional brackets (Mini Diamond) in 20 patients (conventional 10, self-ligating 10). In this study, transpalatal arch was used for anchorage controlled and canines were retracted with NiTi close-coil springs (150g) for 3 visits with 4 weeks interval. Damon3 and conventional bracket showed similar result in canine retraction.

Another study from Costa Monini et al [17] in 2014 which also evaluated the rate of canine retraction on self-ligating bracket system (In-Ovation R, GAC) and conventional bracket system (Ovation, GAC). In this randomized split-mouth control trial in 25 patients, canines were retracted using NiTi closed coil springs (100g) every 4 weeks and the molar movement was controlled with tight fit omega loops at first

molar. The result showed similar rate of canine retraction between self-ligating and conventional brackets.

Treatment time

Pandis et al [18] performed a study in 2007 to compare the time required for relieving mandibular anterior crowding between conventional (Ormco) and self-ligating brackets (Damon2) in 54 patients (conventional 27, self-ligating 27). They found that subjects with moderate crowding (irregularity index 5) were complete 2.7 times faster in self-ligating brackets. Severe crowding (irregularity index >5) showed a similar but less powerful tendency; treatment time in self-ligating bracket group was 1.37 times faster than conventional bracket group, but not reach statistical significance.

A study from Fleming et al [19] in 2010 was carried out in 54 patients with the purpose to compare the duration of treatment between self-ligating (SmartClip) and conventional brackets (twin bracket, Victory), 26 conventional, 28 self-ligating. No statistically significant was found on treatment duration or required visit between 2 groups.

In 2011, DiBiase et al [20] performed randomized clinical trial in 48 patients to compare the efficiency of treatment in terms of overall treatment time, number of appointments and occlusal outcome between self-ligating (Damon3) and conventional brackets (Ormco), 27 Damon3 and 21 Ormco. The outcome of different bracket system on treatment duration, number of visits and occlusal outcome were not significant.

Machibya et al [21] compared treatment duration, outcome and anchorage loss between self-ligating (SmartClip) and conventional brackets (Victory, 3M) in 2013. Self-ligating group consisted of 33 patients and 35 patients in conventional group, total treatment time, treatment outcome and loss of anchorage showed no statistically significant.

In 2015, Juneja et al [22] performed retrospective study in 20 patients to compare and evaluate total treatment time and anchorage loss between self-ligating (SmartClip) and conventional bracket (MBT). The result showed statistically significant reduction in total treatment time in SmartClip group but anchorage loss was similar between 2 groups.

Pain and discomfort

Scott et al [23], 2008, investigated degree of discomfort using VAS during early phase of tooth movement using self-ligating (Damon3) and conventional brackets (Ormco) in 62 patients (33 in Damon3 and 29 in Ormco group). Discomfort in conventional group showed lower level of discomfort than Damon3 group at 4 hours, 24 hours, 3 days and 1 week after archwire insertion but not significant.

Study of Fleming [24] in 2009 was conducted in 48 patients, pain was evaluated with VAS the week after bracket placement and during removal and insertion of archwire, pain experience was compared between self-ligating brackets (SmartClip), 26 patients, and conventional brackets (Victory), 22 patients. Significantly greater discomfort was experienced during archwire insertion and removal with the SmartClip appliance.

Atik and Ciger [3] evaluated pain intensity, using VAS, in 33 patients between two different treatment systems, self-ligating (Damon 3) and conventional brackets (Forestadent) in 2014. The result showed similar pain intensity between 2 groups, pain decreases overtime and showed the same pattern of changes in VAS scores.

Rahman et al [25], 2016, compared pain experience and discomfort between self-ligating (SmartClip) and conventional brackets (Victory). The study was prospective multicenter randomized controlled clinical trial with 113 patients. Pain experience were recorded by verbal rating scale and questionnaires, the pain and discomfort

showed statistically significant, Smart Clip caused more discomfort, but not clinically significant.

Discussion

Treatment Efficiency

Efficiency of orthodontic treatment can be evaluated in various ways. Many studies [9, 10, 12] assessed efficiency of each ligation system by comparing the length of treatment time and overall number of appointments and found no statistically significant between self-ligating system and conventional system [2, 7, 8] found that no significant difference was noted in efficiency of initial rate of alignment for conventional and self-ligating bracket system. In contrast, study of Songra et al [10] in 2014 mentioned that time to initial alignment was significantly shorter for the conventional brackets than for either the active or passive self-ligating brackets.

Transverse Dimension

To compare transverse dimension changes between self-ligating brackets and conventional brackets, Mevlut Celikoglu [13] and Ezgi Atik [3] concluded that both self-ligating brackets and conventional brackets had no significant differences. In initial mandibular alignment, both groups of bracket were increased in incisor inclination, intercanine width and intermolar width but no significant difference was noted. Therefore, it can be concluded that bracket type has little effect on development in changes of transverse dimension.

Canine retraction

From four studies [14-17] that compared the rate of canine movement between the use of conventional brackets and self-ligating brackets, only Burrow's study [14] in 2010 reported that the rate of canine movement was statistically significant faster with conventional brackets while

the other three studies [15-17] reported no difference between two types of bracket system. Burrow suggested that the width of self-ligating brackets was narrower which lead to greater elastic binding and resistance to sliding. The different method of canine retraction was used including elastomeric chain and NiTi closed coil spring which provided no difference in the rate of canine retraction. Although, the study of Costa Monini [17] used only 100g of force during canine retraction while other studies used the force of 150g, no difference in rate of canine retraction were found. For the anchorage control, all of the studies used different methods which were transpalatal arch, tied first molar and second premolar together, and tight fit omega loops at first molar, no different were found between each method of anchorage control. It can be concluded that the rate of canine movement with self-ligating brackets is not faster and maybe slower than that with conventional brackets.

Treatment time

Self-ligating system was faster than conventional system in relieving moderate lower anterior teeth crowding in nonextraction cases but not reach statistical significance. [18] In this review, the studies have done in extraction cases reported that shorter treatment duration with self-ligating brackets but not statistically significant [19-21] except for the study of Juneja [22] in 2015 which showed statistically significant in reduction of total treatment time with self-ligating brackets. Moreover, DiBiase [20] reported that the duration of space closure had a significant effect on the length of treatment but not on the number of appointments and for the total treatment time, no difference between two bracket systems was found.

Pain and discomfort

All studies [3, 23, 25] reported no difference of pain and discomfort between the use of

self-ligating and conventional bracket systems were evaluated the pain during initial archwire insertion, 0.014 NiTi archwire. In contrast, study of Fleming [24] showed significantly discomfort in self-ligating brackets (Smart Clip) during 0.019 x 0.025 insertion and removal. Pain and discomfort may increase as the size of wire has increased and level of pain would decrease over time. In the study of Rahman [25] which recorded the pain score in larger sample size showed statistically significant more discomfort in self-ligating group but not reach clinical significance. Thus, study of pain and discomfort in larger sample size and with different archwire size are required to conclude whether the self-ligating brackets cause more pain and discomfort or not.

Conclusion

Based on currently available data, weak evidence supports that self-ligating system are superior to conventional bracket system. More high-quality clinical trials to verify the long-term effects are needed to draw more reliable conclusions.

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