

## A META-ANALYSIS OF SELF-LIGATING BRACKETS

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### Abstract

**Background:** Self-ligating bracket systems are in trend now a days in comparison to conventional brackets. Various advantages are claimed for these systems. The purpose of this systematic review research was to assess and review the orthodontic literature in terms of treatment time, chair side time, arch dimension, effectiveness, efficiency and treatment stability.

**Materials and Method:** An electronic search in 2 data bases, PubMed, and Cochrane Library—from 1966 to 2017 were investigated with the help of a senior research librarian at the Institute's Library. There were no limitations related to publication status or language. Data was collected on the basis of inclusion and exclusion criteria. Titles as well as Abstract of the weighted articles for the inclusion criteria were identified by minimum two investigators to eliminate the interoperator discrepancy. In case, 2 reviewers disagree then third investigator was pulled.

**Results:** 20 articles were sidelined according to the inclusion criteria. Self-ligating brackets appeared to have significant advantage over conventional brackets. Their use resulted in less chair side time and treatment time, maintaining the arch dimension, increased effectiveness and efficiency of faster incisor alignment.

**Conclusions:** Self-ligating brackets are statistically superior to conventional brackets in terms of chair side time, treatment time, arch dimension, maintenance, treatment stability, effectiveness and efficiency.

**Key words:** Self-ligating brackets; conventional brackets; Meta-analysis; Systematic review.

### Introduction

Self-ligating brackets are increasingly becoming part of orthodontic treatment modality<sup>1-7</sup>, was introduced by Stolzenberg, In 1930s this was the first self-ligating bracket<sup>8-9</sup>.

According to mechanism of closure there are two types of Self-ligating brackets i.e. (1) Active Self-ligating bracket - This type of bracket system has a spring clip that presses towards the arch wire for torque control and rotation. (2) Passive Self-ligating bracket - This type of bracket system does not apply any active force on arch wire, contains a slide which can be closed and does not exert any force on lumen slot<sup>10</sup>. The aim of this article was to conduct a systematic search of eligible publications from the past 17 years, and to conduct a meta-analysis on differences between conventional and Self-ligating brackets regarding (1) Efficiency (2) Stability (3) Overall treatment time (4) Effectiveness (5) Chair side time (6) Arch dimension<sup>11,12</sup>. Advantages of self-ligating brackets are reduced friction<sup>13-17</sup>, better sliding mechanics<sup>18,19</sup>, secure wire ligation ,anchorage conservation<sup>18,19</sup>, reduced treatment time, less number of visit<sup>20</sup>, less chair side time<sup>2,18,21</sup>, better infection control<sup>22</sup>, enhanced patient compliance<sup>18,19</sup> and improved oral hygiene<sup>23-25</sup>. Disadvantages of self-ligating brackets they are expensive, probability of clip breakage, high profile, the problem faced at the time of finishing that occurs due to incomplete expression of arch wire and lip discomfort<sup>26</sup>. By closing and opening of the bracket which turn those bracket slots into a tube containing wire that is either active or passive is the fundamental

Mechanism of the self-legating bracket, with the absence of wire ligatures or elastomeric ties the movement of tooth occurs at a greater velocity along with dramatical reduction of frictional resistance<sup>27-28</sup>.

### Inclusion criteria

1. The study that identifies the differences between conventional and self-ligating bracket system regarding their stability, treatment time, chair side time, efficiency, effectiveness and arch dimension.
2. Patients of any age and sex.
3. This study includes randomized control trial, prospective study, and retrospective study.
4. This study included studies that had been conducted in any country.

**Exclusion criteria:-**All studies with bias, In-vitro and ex-vivo study, Animal studies, Studies with no comparison group.

**Electronic data bases:** — PubMed, and Cochrane Library—from 1966 to 2017 were investigated with the help of a senior research librarian at the Institute's Library. Sample size of Electronic searches included 160 titles and abstract. Period of study was 10 to 12 months. (Fig. 1)

**Procedure:-**

**Title** as well as **Abstracts** of the weighted articles with the inclusion criteria was identified by minimum two investigators. Abstracts of articles contained 92 inclusion characteristics that were uncertain & identified, though the complete articles were also retrieved if as and when necessary. Grey literature can be included, but at last, only articles that were published, pre-reviewed was included in the study. After compiling all the articles that are to be included, we includes two reviewers who reads the articles & abstract, classify the list of more articles that should be included in the study. Prior to selection, these article were tested and categorized into two types mainly cohort study and randomized control trials. The list of references can also be searched in case it is required. In case, when two investigators disagree, a third investigator intervenes. For independent quality assessment a modified version of Newcastle-Ottawa scale is used by two reviewers. In case of disagreement, a third reviewer can be consulted & consent is obtained after a thorough discussion.

**Statistical Analysis:-**

The data thus obtained will be subjected to statistical analysis using forest plot. Descriptive statistical tests like standard mean difference, odd ratio, relative risk, 95% CI using REVMAN software.

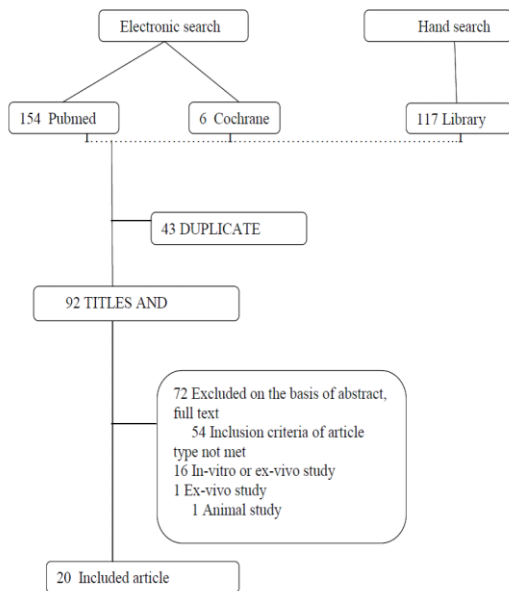


Figure 1. Flow diagram of literature search

**Materials and Methods –**

It is an in-vitro study to recognize and assess the orthodontic literature on the basis of efficiency, stability and effectiveness of treatment of Self-ligating brackets as compared to conventional brackets.

**Results-**

The electronic searches identified 160 titles and abstracts and 117 articles added from hand searching. From these, 92 full articles were retrieved for review. Ultimately, 20 articles met the inclusion criteria (Fig 1). Characteristics of the included articles are listed in Table I.

Characteristics of the excluded articles are listed in Table II.

**Table I - Characteristics of included studies**

Author	Year	Design	Self-ligating group (number of patients)	Conventional group (number of patients)	Authors' conclusion	mean age (y)
Basciftci et.al. <sup>29</sup>	2014	Retrospective study	Damon self-ligating brackets (24)	Type not specified	Self-ligating brackets are more stable than conventional brackets with regard to inter-canine, inter-premolar, inter-molar width.	14.23±2.19
Zhou yu <sup>30</sup>	2014	Retrospective study	Active and passive self-ligating brackets	type not specified	Self-ligating brackets are more stable than conventional brackets in terms of maxillary and mandibular arch length, inter-canine and inter-molar width.	13.56(SL) 7.24 (CL)
Haradine <sup>2</sup>	2001	Retrospective study	Damon self-ligating brackets(50)	type not specified (50)	Self-ligating brackets shows less treatment time than conventional brackets but slide opening and space closure faster in conventional	Not reported

					group.		et. al. <sup>35</sup>		ospe ctive Coho rt study	(108)	specified (107)	treated with Damon SL had significan t less treatment times, less number of visit and less American Board of Orthodon tics scores than those treated with Conventi onal Brackets.	repor ted
Turnbul and Birnie et. al. <sup>31</sup>	2007	Cros s- secti onal  Stud y	Damon (14)	Type not specified (122)	Self- ligating brackets show less chair side treatment time compare with Conventi onal brackets	13.7 (SL) 14.4 (CL)							
Ezgi Atik et.al. <sup>32</sup>	2014	Rand omiz ed contr ol trial	Damon (16)	Roth prescribed edgewise brackets	No significan t differenc e between self- ligating brackets with conventio nal brackets in terms of arch dimensio n.	14.8 (SL) 14.5 (CL)	Hamilton et. al. <sup>36</sup>	2001	Retr ospe ctive Coho rt	Damon SL (30)	Type not specified (30)	Self- ligating brackets shows significan t advantag e in term of treatment time, number of visits, and time spent in initial alignmen t over conventio nal brackets but number of debonded brackets and other emergenc y visits higher in patients treated with self- ligating Brackets.	Not repor ted
Emily Ong et. al. <sup>33</sup>	2010	Retr ospe ctive and pros pecti ve study	Damon (44)	Type not specified (40)	No significan t differenc e between self- ligating and conventio nal bracket in terms of efficienc y.	Not repor ted							
Ezgi Atik et. al. <sup>34</sup>	2016	Retr ospe ctive study	Active (15) Passive(16 )	Roth prescriptio n (15)	No significan t change between self- ligating and conventio nal brackets system in terms of arch dimensio n	14.4 (acti ve SL) 14.8 (pass ive SL) 14.4 (CL)	Miles et. al. <sup>4</sup>	2006	Retr ospe ctive coho rt study	Type not specified (58)	Type not specified (58)	Self- ligating brackets shows no more efficient in terms of incisor alignmen t conventio nal brackets.	Not repor ted
Ebertin-g	2001	Retr	Damon SL	Type not	Patients	Not	Jiang	2008	Pros	Damon	Conventio	In	Dam

and Fu et.al. <sup>37</sup>		pective Cohort	(13)	n-al metal preadjusted brackets (13)	patients with crowding treated without extractions, there were overall increases in the proclination of the Mandibular incisors and arch widths in both groups. Patients treated with Damon3 had greater intermolar width increases than those treated with Conventional appliance s.	on-14.5 Conventional-15.3					and proclination of Mandibular incisors for Both appliances, but the Difference were not Significant.		
							Pandis et. al. <sup>39</sup>	2009	Prospective cohort	Damon2 (27)	conventional (27)	Result shows no significant difference between self-ligating and conventional -brackets in terms of mandibular incisor proclination and arch dimension.	13.6 (SL) 13.9 (CL)
Scott et. al. <sup>38</sup>	2008	Randomized Controlled trial	Damon 3 (32)	Conventional (28)	Damon 3 was no more Efficient than conventional Brackets in initial or Overall rate of mandibular Incisor alignment. Alignment was associated With increased inter-canine Width, maintenance of Intermolar width, some Reduction of arch length,	Damon3: 16.2 Conventional: 16.4	Rohaya et.al. <sup>40</sup>	2012	Prospective clinical trial	Damon (14)	Conventional(15)	Conventional bracket show significant faster tooth alignment compare with self-ligating bracket but no significant difference seen between self-ligating and conventional bracket system.	Not reported
							Miles et. al. <sup>41</sup>	2005	Randomized control trial	Type not specified (29)	Conventional (31)	Self-ligating brackets more efficient than conventional bracket	Not reported

					system with regard to incisor alignment.	
Jayachandran <sup>42</sup>	2017	Randomized controlled trial	Damon (10)	Conventional (10)	Self-ligating show minimal rate of retraction, amount of incisor movement and amount of anchor less efficient than conventional	
Hamilton et al. <sup>36</sup>	2008	Retrospective cohort	In Ovation (379)	Victory (383)	No significant difference between self-ligating brackets and conventional brackets in terms of treatment time, number of visits, and time spent in initial Alignment.	Not reported
Flemming et al. <sup>43</sup>	2010	Randomized controlled trial	Smart-clip(28)	Victory(28)	No significant difference between self-ligating bracket and conventional bracket system in terms of treatment time.	Not reported
Johanson et al. <sup>44</sup>	2012	Randomized controlled trial	44-self ligating brackets	46-conventional brackets	No measurable difference between self-ligating	Not reported

					and conventional group in terms of number of visit and treatment time	
Machibya et al. <sup>45</sup>	2013	Retrospective cohort study	34- smart clip	35 – conventional group	No measurable difference between self-ligating and conventional group in terms of number of visit and treatment time.	Not reported

1. Total treatment time (in month), presented in standardized mean difference -

The meta-analysis includes 7 studies that shows the treatment time are significant with self-ligating brackets. Study of Diabase, Eberling, Ferdinaand, Fleming, Hamilton, and Haradine, support the self-ligating brackets but the study of Kristina support the conventional bracket system. Study shows more heterogeneity ( $p < 0.0001$ ,  $I^2 = 87\%$ ). Study of Fleming shows maximum weight. (Fig. 2)

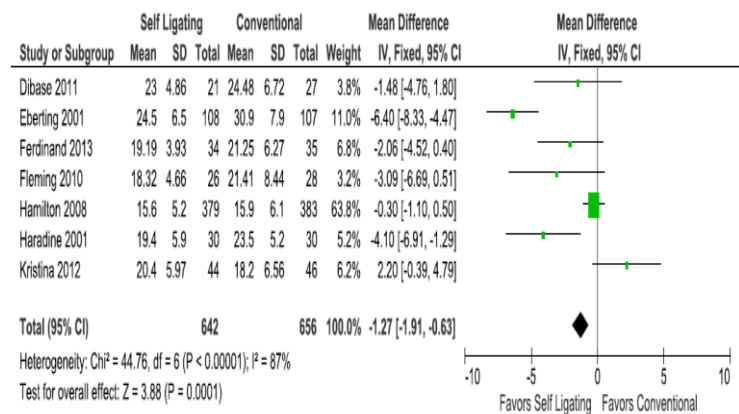


Figure 3. Total chair time (in minutes), presented in standardized mean difference

3. Occlusal indices at the end of the treatment, presented in standardized mean difference -

A meta-analysis of 3 studies shows that the occlusal indices support the self-ligating brackets. Study of Eberling, Hamilton, and Haradine also support the self-ligating brackets. Study of Haradine shows more weight.

Study shows more heterogeneity ( $P = 0.0002$ ,  $I^2 = 88\%$ ). (Fig. 4).

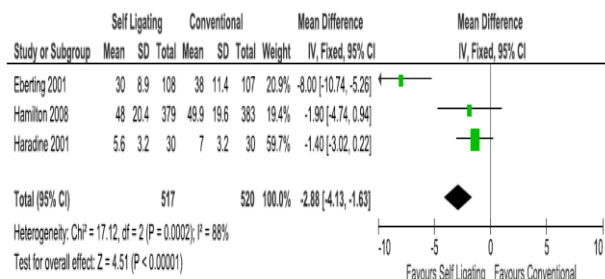


Figure 4. Occlusal indices at the end of the treatment, presented in standardized mean difference

4. *Incisor inclination change, positive mean proclination* - A meta-analysis of 3 studies shows that the incisor inclination is more in self-ligating brackets. Study of Pandis and Scott also support the self-ligating brackets but the study of Jiang support the conventional bracket system. Study of Pandis and Scott shows more weight. Study shows more heterogeneity ( $P = 0.30$ ,  $I^2 = 18\%$ ). (Fig. 5)

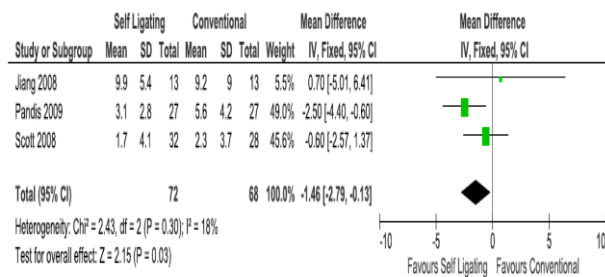


Figure 5. Incisor inclination change, positive mean proclination

5. *Mandibular incisor alignment (change of irregularity index at 10 weeks of alignment)* - A meta-analysis of 2 studies shows that the mandibular incisor alignment after 10 week of alignment are faster with conventional brackets. Study of Miles also support the self-ligating brackets. Study of Miles shows more weight. Study shows more heterogeneity ( $P = 0.44$ ,  $I^2 = 0\%$ ). (Fig. 6)

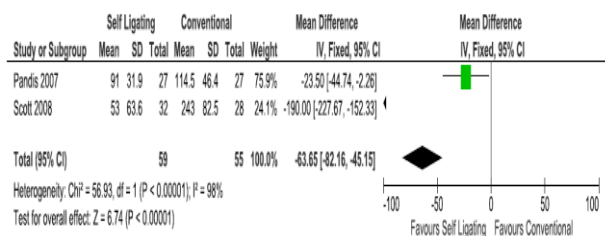


Figure 6. Mandibular incisor alignment (change of irregularity index at 10 weeks of alignment)

6. *Mandibular incisor alignment (change of irregularity index at 20 weeks of alignment)* - A meta-analysis of 2

studies shows no statistically significant difference with regard to mandibular incisor alignment after 20 week of alignment. Study of Miles shows that self-ligating bracket system are not more significant than the conventional bracket system. Study of Miles shows more weight. Study shows more heterogeneity ( $P = 1.00$ ,  $I^2 = 0\%$ ). (Fig. 7)

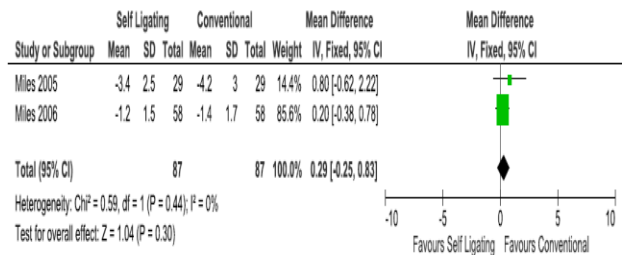


Figure 7. Mandibular incisor alignment (change of irregularity index at 20 weeks of alignment)

7. *Mandibular incisor alignment at the end of the treatment, presented in standardized mean difference* -

A meta-analysis of 2 studies shows that the mandibular incisor alignment is faster with self-ligating brackets. Study of Pandis and Scott also support the self-ligating brackets. Study of Pandis shows more weight. Study shows more heterogeneity ( $P < 0.00001$ ,  $I^2 = 98\%$ ). (Fig. 8)

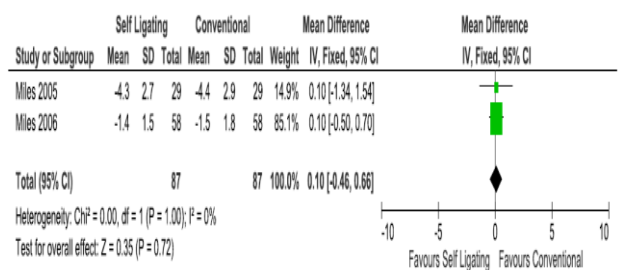


Figure 8. Mandibular incisor alignment at the end of the treatment, presented in standardized mean difference.

8. *Change in maxillary inter-canine width, presented in standardized mean difference* - A meta-analysis of 2 studies shows no significant difference between self-ligating brackets and conventional bracket system with regard to maxillary inter-canine width. Study of Ong shows that self-ligating brackets statistically more significant than conventional brackets but Zhou study shows no significant difference between self-ligating bracket system and conventional bracket system. Study of Ong shows more weight. Study shows more heterogeneity ( $P = 0.68$ ,  $I^2 = 0\%$ ). (Fig. 9)



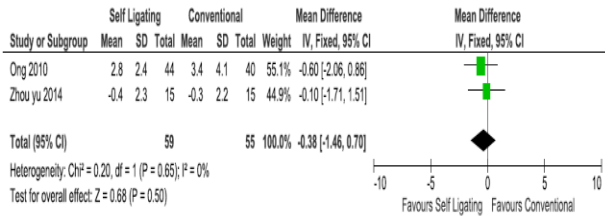


Figure 9. Change in maxillary inter-canine width, presented in standardized mean difference

9. Change in mandibular inter-canine width, presented in standardized mean difference - A meta-analysis of 2 studies shows no statistically significant difference between self-ligating bracket system and conventional bracket system in terms of mandibular inter-canine width. Study of Ong shows that self-ligating bracket system are more significant than conventional bracket system but Zhou shows no significant difference between Self-ligating and conventional system. Study of Ong shows more weight. Study shows more heterogeneity (P = 0.15, I<sup>2</sup> = 51%). (Fig. 10)

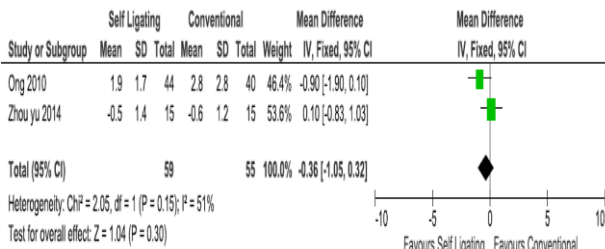


Figure 10. Change in mandibular inter-canine width, presented in standardized mean difference

10. Change in maxillary inter-molar width, presented in standardized mean difference - A meta-analysis of 2 studies shows no statistically significant difference between self-ligating bracket system and conventional bracket system with regard to maxillary inter-molar width. Study of Ong and Zhou shows no significant difference between self-ligating bracket system and conventional bracket system. Study of Ong shows more weight. Study shows more heterogeneity (P = 0.86, I<sup>2</sup> = 0%). (Fig. 11)

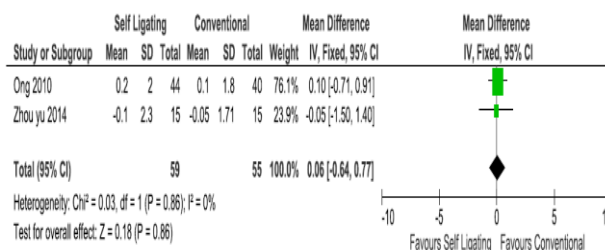


Figure 11. Change in maxillary inter-molar width, presented in standardized mean difference

11. Change in mandibular inter-molar width, presented in standardized mean difference - A meta-analysis of 2 studies shows no statistically significant difference between self-ligating brackets and conventional bracket system in relation to mandibular inter-molar width. Study of Ong and Zhou shows no significant difference between self-ligating and conventional system. Study of Ong shows more weight. Study shows more heterogeneity (P = 0.83, I<sup>2</sup> = 0%). (Fig. 12)

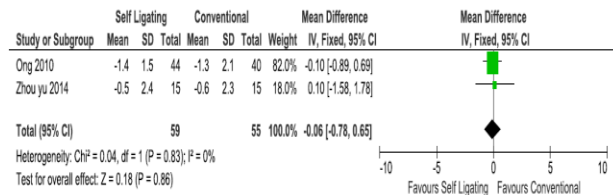


Figure 12. Change in mandibular inter-molar width, presented in standardized mean difference

12. Change in inter 1<sup>st</sup> premolar width, presented in standardized mean difference - A meta-analysis of 2 studies shows that the change in inter 1<sup>st</sup> premolar width is more with self-ligating brackets. Study of Atik also support the self-ligating brackets. Study shows more heterogeneity (P = 0.42, I<sup>2</sup> = 0%). (Fig. 13)

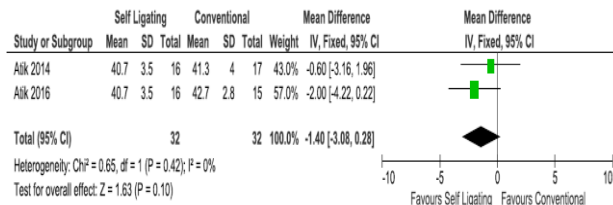


Figure 13. Change in inter 1<sup>st</sup> premolar width, presented in standardized mean difference

13. Change in inter 2<sup>nd</sup> premolar width, presented in standardized mean difference - A meta-analysis of 2 studies shows that the change in inter 2<sup>nd</sup> premolar width is more with Self-ligating brackets. Study of Atik favour the self-ligating brackets. Study shows more heterogeneity (P = 0.49, I<sup>2</sup> = 0%). (Fig. 14)

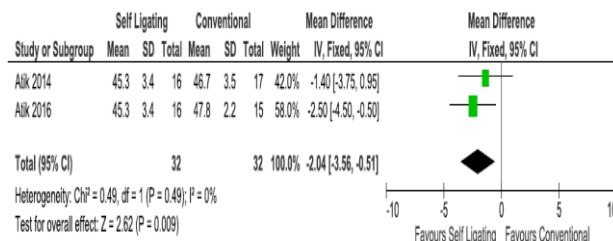


Figure 14. Change in inter 2<sup>nd</sup> premolar width, presented in standardized mean difference

**Discussion – Chair side time-** Only two studies have similar methods and sufficient statistics to allow pooling of the data for meta-analysis. The result shows a saving of 20 seconds of chair time in Self-ligating bracket system. Haradine et al<sup>2</sup> and Tumbell et al found significantly less time of treatment in self ligating bracket system compared with conventional bracket system. Present meta-analysis also supported the Haradine et al<sup>2</sup> and Tumbell et al study.

**Occlusal indices-** Harradine et al<sup>2</sup> and Eberting et al<sup>35</sup> evaluated significant difference between conventional and self-ligating bracket system with regard to improvement in mean score using American Board Of Score. Hamilton et al<sup>36</sup> evaluated no significant difference in between self-ligating bracket system and conventional bracket system with the use of index of complexity, outcome, and need. Our meta-analysis shows that the overall effect of all the studies is in the favour of Self-ligating bracket system.

**Incisor inclination -**Jiang et al<sup>37</sup> found overall increase in the mandibular incisor proclination with self-ligating bracket but when compared the cases treated with conventional bracket, the change of the lower incisor inclination was influenced not only by the mandibular crowding and the inter-molar width before treatment but also by the patient's skeletal pattern and the changes of the arch width during treatment. Scott et al<sup>38</sup> and Pandis et al<sup>39</sup> evaluated no significant difference between self-ligating bracket system and conventional bracket system with respect to incisor inclination. Present meta-analysis shows that overall effects of all the studies is in the favour of self -ligating.

**Mandibular incisor alignment -** Pandis et al<sup>39</sup> found overall increase in the mandibular incisors proclination along with correction of crowding in both groups and no significant difference was evaluated between Self-ligating and conventional bracket system in this parameter. Scott et al<sup>38</sup> evaluated no significant difference in the initial or the overall rate of alignment mandibular incisor between self-ligating and conventional bracket system. The only significant influence on initial rate of incisor alignment was the amount of initial irregularity. Our study shows that self-ligating brackets are more statistically significant than conventional bracket. Miles et al<sup>41</sup> found that conventional bracket are more efficient than self-ligating bracket after 10 weeks but no significant difference after 20 week of initial alignment. Our meta-analysis also supported Miles et al<sup>41</sup> after 10 and 20 weeks of initial alignment.

**Inter canine width -**Scott et al<sup>38</sup>, Pandis et al<sup>39</sup>, Atik et al<sup>34</sup> evaluated no significant difference between self-ligating bracket system and conventional bracket system

in terms of change in inter-canine width but our meta-analysis shows that self-ligating bracket system are more efficient than conventional bracket system in terms of change in inter-canine width. Ong et al<sup>33</sup> and Zhou et al<sup>30</sup> found no significant difference between self-ligating bracket system and conventional bracket system in terms of change in maxillary and mandibular inter-canine width. Our meta-analysis also shows no statistically significant difference between self-ligating and conventional bracket system with regard to change in maxillary and mandibular inter-canine width.

**Inter molar width -** Scott et al<sup>38</sup>, Pandis et al<sup>39</sup>, Atik et al<sup>30</sup> evaluated no significant difference between Self-ligating and conventional bracket system with regard to inter-molar width. Our meta-analysis results shows that conventional bracket system increases inter-molar width more than Self-ligating bracket system. Ong et al<sup>33</sup> and Zhou et al<sup>30</sup> found no significant difference between self-ligating bracket system and the conventional bracket system with regard to change in maxillary and mandibular inter-molar width. Present meta-analysis also shows no statistically significant difference between the self-ligating bracket system and conventional bracket system in terms of change in maxillary and mandibular inter-molar width.

**Inter 1<sup>st</sup> and 2<sup>nd</sup> premolar width -**Atik et al<sup>34</sup> found that no significant difference between self-ligating and the conventional bracket system in terms of change in first and second inter-premolar width but our meta-analysis shows that self-ligating bracket increases inter-premolar width more than conventional bracket system.

**Other-** Wahab et al<sup>40</sup> found that self-ligating brackets are not superior to the conventional bracket system with respect to tooth alignment, although the alignment of incisor teeth during the first month was at a significantly faster rate. Jayachandran et al<sup>42</sup> found that the self-ligating brackets are more efficient than conventional brackets in comparison of rate of retraction on right and left side. Fleming et al<sup>43</sup> evaluated no significant difference between self-ligating bracket and the conventional bracket system with regard to number of visits. Zhou et al<sup>30</sup> found no significant difference between self-ligating bracket system and conventional bracket system with regard to maxillary and mandibular arch length. Ong et al<sup>33</sup> found no significant difference with regard to maxillary and mandibular arch depth in Self-ligating bracket system.

**Conclusions -** Self-ligating brackets shows statistically less treatment time, less chair side time as compared to conventional brackets. Self-ligating bracket system are more efficient than conventional bracket system. On the basis of stability self-ligating brackets system shows more stable results compared with conventional bracket system.

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