The Online
ANGLE ORTHODONTIST
An International Journal of Orthodontics and Dentofacial Orthopedics
78th Anniversary 1930–2008



Proudly Sponsored by *The EH Angle Education and Research Foundation*

[Print Version]
[PubMed Citation] [Related Articles in PubMed]

TABLE OF CONTENTS



---

*The Angle Orthodontist:* Vol. 76, No. 3, pp. 480–485.

# A Clinical Trial of Damon 2™ Vs Conventional Twin Brackets during Initial Alignment

**Peter G. Miles;[a] Robert J. Weyant;[b] Luis Rustveld[c]**

## ABSTRACT

The objective of this study was to compare the effectiveness and comfort of Damon 2 brackets and conventional twin brackets during initial alignment. Sixty consecutive patients participated in a split mouth design. One side of the lower arch was bonded with the Damon 2 bracket and the other with a conventional twin bracket. The sides were alternated with each consecutive patient. The irregularity index (II) was measured for each half of the arch at baseline, at 10 weeks at the first archwire change, and at another 10 weeks at the second archwire change. Any difference in discomfort was assessed within the first few days of archwire placement and again at the first archwire change. Comfort on the lips, preferred look, and bracket failure rates were also recorded. The twin bracket was more uncomfortable with the initial archwire ($P$ = .04). However, at 10 weeks, substantially more patients reported discomfort with the Damon 2 bracket when engaging the archwire ($P$ = .004). At both archwire changes at 10 and 20 weeks ($P$ = .001), the conventional bracket had achieved a lower II than the Damon 2 bracket by 0.2 mm, which is not clinically significant. Patients preferred the look of the twin bracket over the Damon 2 ($P$ < .0005) and more Damon 2 brackets debonded during the study ($P$ < .0005). The Damon 2 bracket was no better during initial alignment than a conventional bracket. Initially, the Damon 2 bracket was less painful, but it was substantially more painful when placing the second archwire and had a higher bracket failure rate.

**KEY WORDS:** Friction, Self-ligating, Damon, Clinical trial.

Accepted: June 2005. Submitted: April 2005

## INTRODUCTION Return to TOC

Efficiency of treatment mechanics is a major focus in modern orthodontics. During orthodontic tooth movement with the preadjusted edgewise system, friction generated at the bracket/archwire interface may impede the desired movement. Several studies have investigated the principal factors that may influence orthodontic frictional resistance. These factors include relative bracket-wire clearances,[1] archwire size,[2,3] archwire section (round vs rectangular wires),[4] torque at the bracket-wire interface,[4] surface conditions of the archwires and bracket slot,[5] bracket and archwire materials,[6–9] bracket slot width,[4] bracket type (conventional vs self-ligating [SL] brackets),[6,10–12] type and force of archwire ligation.[6,10,13–17] Some SL brackets are promoted on the premise that elimination of ligatures creates a friction-reduced environment and allows for better sliding mechanics. It would then be expected that the SL bracket may reduce the treatment time.[18]

SL brackets are not new, with the “Russell Lock” edgewise attachment being described in 1935.[19] More recently, other designs have appeared including the Speed Bracket™ in 1980, the Time™ bracket in 1994, the Damon SL™ bracket in 1996, the TwinLock™ br 1998, and the Damon 2™ and Innovation™ brackets in 2000.[20] The most recent additions are the Damon 3™ and SmartClip™ bracket 2004. Several papers have reported that the Damon bracket (which has a “passive” slide) demonstrated lower friction than the Speed or Time brackets (which have a potentially “active” slide).[21–23] Damon[24] has described the clinical use of these brackets and proposed that this low friction is a major factor in enabling more efficient treatment.

One study used typodont models having different degrees of malocclusion to simulate low- and high-friction scenarios.[25] SL brackets outperformed conventional brackets when smaller archwires were engaged, but when larger archwires were engaged, the two bracket types were more comparable. On the basis of this and previous research, Henao and Kusy[25] stated that this conclusion validates the contention that laboratory results can predict clinical outcomes. However, little clinical evidence exists as to the efficacy of these brackets to support this.

Modern SL brackets are certainly faster to tie and untie, saving up to 2–3 minutes compared with modules.[26] Another study found a reduction in archwire placement/removal of 24 seconds per arch.[20] In addition, a mean reduction of four months in treatment time (from 23.5 to 19.4 months) and a mean reduction of four visits during active treatment (from 16 to 12) was reported.[20] A clinical study in three practices found an average reduction in treatment time of six months (from 31 to 25) and seven visits (from 28 to 21) for Damon SL cases compared with conventional ligation.[18] These reports support a view of clinically significant improvements in treatment efficiency with passive SL brackets. However, it is not clear what techniques were used or which variables were controlled.

Retrospective studies such as these are potentially biased despite apparent matching because there are many uncontrolled factors, which may affect the outcome. These include greater experience, differing archwires, altered wire sequences, and modified appointment intervals. Observer bias may inadvertently affect the result because the practitioner may be doing “a little more” due to enthusiasm with the new appliance or technique. These factors may have played a major role in reducing treatment time.

Apart from faster ligation, lower friction, and reduced appointment and treatment times, claims made by manufacturers' promotional material regarding SL brackets include lower forces, reduction or elimination of headgear and rapid palatal expansion, improved facial esthetics, reduced emergencies, reduced expense, less painful, improved comfort on the lips, less decalcification, and a reduced risk of carpal tunnel injury.

The purpose of this study was to compare the effectiveness as well as the comfort of Damon 2™ SL brackets vs conventional twin brackets during the initial leveling and alignment stage of treatment in the lower arch.

## MATERIALS AND METHODS Return to TOC

Sixty consecutive patients who met the selection criteria were prospectively selected from the private orthodontic clinic of the author. Thirty-seven patients failed to meet the following selection criteria to participate in the study: (1) 14 had chosen all esthetic lower brackets over metal, (2) nine patients were not symmetrical, either having asymmetrical extractions or missing teeth, (3) six had upper arch treatment only, (4) five did not have all brackets placed at the same appointment because of severe rotations or partially erupted teeth, (5) one had lower brackets placed on the anterior teeth only, (6) one had the lower brackets flipped for torque control, and (7) one was omitted as a patient for board assessment. All patients were informed of the purpose of the study but were not aware of which bracket was of a newer design. None declined to participate.

Consecutive eligible patients were alternated between two groups in a split mouth study design. Group 1 had the mandibular right quadrant indirectly bonded with 0.022-inch Damon 2 brackets (ORMCO, Glendora, Calif) and the left side with standard profile 0.022-inch Victory MBT brackets (3M/Unitek, Monrovia, Calif). Group 2 had the opposite sides bonded to group 1. Both bracket types used were of the same tip and torque prescription.

The Irregularity Index (II), defined as the summed displacement of adjacent anatomic contact points of the six mandibular anterior teeth, was used to quantify the degree of alignment.[27] The II was measured intraorally using a digital caliper (150 mm ECP-015D digiMax caliper, Moore and Wright, Buchs, Switzerland) to the nearest 0.1 mm (caliper resolution = ±0.01 mm) between the mandibular canine and lateral incisor and the lateral incisor and central incisor and summed to give the II for each half of the arch.

The initial wire was a 0.014-inch Damon copper NiTi wire (ORMCO) and the conventional twin brackets were ligated with silver colored elastomeric modules (3M/Unitek) to make the difference in bracket type less obvious to the patient. If the wire did not engage fully in the twin bracket with an elastomeric module, it was tied in a figure eight to more completely engage the wire. No stainless steel ligatures were used. At the first wire change at 10 weeks, a 0.016 × 0.025-inch Damon copper NiTi wire (ORMCO) was placed and the II measured and this was again measured after another 10 weeks to assess the alignment achieved by each bracket type. These wire types, sizes, and arch forms were the most commonly recommended initial archwires in the Damon literature from ORMCO.

The patients were recalled within the first few days of bracket placement to assess whether the teeth on one side were more or less

painful than the other and whether the brackets felt more or less comfortable on the lips. Discomfort was assessed again at the first wire change as to whether one side was more or less comfortable when untied and when the new wire was ligated. Patients were also asked whether they had any preference in the look of one bracket type over the other. Bracket failure rates were recorded for each group over the 20 weeks of the study.

To assess the accuracy of measuring the II for each half of the arch, 10 consecutive subjects not involved in the study were measured on two occasions. The repeated measures were compared for correlation and a paired *t*-test performed to assess the accuracy and reproducibility of the method. A mean absolute difference between measures of 0.08 mm was recorded with a correlation coefficient of $r = 1$ and the *t*-test resulted in a $P = .48$, which indicated statistically and clinically acceptable accuracy in measuring the II.

## RESULTS Return to TOC

Of the 60 patients included in this study, one transferred and so the corresponding adjacent patient was deleted to maintain equal numbers. This left a total of 58 subjects (40 females, 18 males, average age of 16.3 years; min 10.5 years, max 46.5 years). Because the data were paired from contralateral quadrants from each patient and were not normally distributed, the statistical analysis involved the use of the nonparametric Wilcoxon signed rank test (Tables 1 and 2).

There was no pretreatment difference in the irregularity between the Damon 2 side (II = 2.0) and the conventional twin bracket side (II = 2.1, $P = .98$). Patient's preferred the look of the conventional twin bracket (n = 14) over the Damon 2 (n = 0, $P < .0005$). Although more patient's reported discomfort on the lips with the Damon 2 (n = 10) vs the conventional twin bracket (n = 4), this was not statistically significant ($P = .11$). More patients reported discomfort in the first few days after placement of the initial 0.014-inch archwire with the conventional twin bracket (n = 9) than with the Damon 2 (n = 2, $P = .04$). At the first wire change at 10 weeks, no significant difference in discomfort was reported when untying the archwire ($P = .56$). However, when engaging the 0.016 × 0.025-inch archwire, substantially more patients reported discomfort with the Damon 2 bracket (n = 21) than with the twin bracket (n = 6, $P = .004$).

At both the first archwire change at 10 weeks and the second archwire change at 20 weeks there was a statistically significant difference ($P = .001$) because the twin bracket had achieved a 0.2-mm lower II than the Damon 2 bracket. Throughout the 20 weeks of the study, more Damon 2 brackets (n = 26 of 282) debonded than conventional twin brackets (n = 5 of 282, $P < .0005$).

## DISCUSSION Return to TOC

Very low classical friction with various designs of SL brackets has clearly been demonstrated within the literature with passive ligation being superior to active ligation in this regard.[23] However, the assumption has been made that along with low friction in vitro comes more rapid alignment and a reduction in treatment time in vivo. The results of this study demonstrate that during the initial alignment phase of treatment, the Damon 2 bracket had 0.2 mm greater irregularity, so clinically it did not perform any better than the conventional twin bracket (Figure 1).

The mean difference in irregularity of 0.2 mm could be attributed to the lack of engagement of the 0.014-inch wire by the passive Damon 2 bracket, which allows 8.5° of rotational play compared with a theoretically fully engaged conventional twin bracket. The second 0.016 × 0.025-inch archwire was more active in the passive slot of the Damon 2 but still not fully engaged because of the 0.028-inch slot depth of the Damon 2 bracket leaving 1.8° of rotational play ($0.0275'' + 0.0010''/-0.0000''$ slot tolerance, data supplied by ORMCO). With this degree of rotational play, the average lower incisor irregularity for half of the arch based on average lower incisor widths would also equal 0.2 mm. Although this result could be affected by bracket positioning, it is unlikely because both sides were indirectly bonded by the author (Dr Miles) and subject to the same degree of bracket placement error. Because the measurement error was 0.08 mm, this could contribute to the 0.2-mm difference.

Individual patient's teeth will respond differently to the same applied pressure, so a split-mouth design was used to allow direct comparison of the response to each bracket type for each person. It also allows each patient to give a personal comparison of preference and comfort between each bracket type without requiring a visual analogue scale, which eases data gathering in a private practice environment. One possible criticism of this split-mouth study design is that having conventional brackets with elastomeric modules on half the arch inhibits the free sliding of the Damon 2 bracket past the midline. However, the Damon technique advocates the use of midline archwire stops so interference is already present. In addition, the wire can still slide freely distal to the midline and therefore it may only diminish but not cancel out any effect as found in this study.

Initially the Damon 2 bracket was slightly less painful, which was likely due to incomplete engagement applying less pressure. The conventional brackets were ligated with modules and a figure eight configuration used when required for more complete engagement. The significantly greater discomfort reported when ligating the second 0.016 × 0.025-inch copper NiTi archwire in the Damon 2 bracket may be due to operator inexperience. However, the slightly greater irregularity on the Damon 2 side after the initial archwire made it more difficult to engage the second archwire than on the conventional twin side, which could explain the greater discomfort. No significant difference in comfort to the lips was reported but patients did prefer the look of the conventional twin bracket over the Damon 2 when silver modules were used.

Treatment efficiency involves several factors including breakages. A higher bracket failure rate results in extra visits for the patient and additional clinical time required for repairs. The five times higher bracket failure rate demonstrated by the Damon 2 would need to be offset by any time saving in ligation time as well as overall treatment time. This higher failure rate could be due to operator inexperience with the slide mechanism and also due to the bracket design because a shear force can be inadvertently applied when operating the slide. This could not be assessed in this study because the exact cause of failure was not recorded. The Damon 2 is also larger incisogingivally than the conventional twin bracket used and so more likely to interfere with the occlusion. Both bracket types were bonded using the same indirect bonding method and adhesive. However, the custom bases were different with the conventional brackets being precoated (APC Plus), whereas the Damon 2 brackets had adhesive applied (Light-Bond, Reliance Orthodontic Products, Ithaca, Ill). This could affect the breakage rates, but the site of failure of the adhesive was not recorded so this could not be assessed. Because both custom base materials have been used in previous studies with 1.4% and 2.3% failure rates, this is unlikely to be a major contributor.[28,29]

Previous works by Harradine[20] and Eberting et al[18] found a reduction in treatment time and number of visits when using Damon SL brackets. Apart from the potential risk of bias with these retrospective study designs discussed earlier, if there is a true reduction in treatment time it would appear that this is not during the initial alignment stage of treatment. Any time savings may be in later stages of treatment, particularly during space closure in extraction cases. The sample in this study had a 20% extraction rate vs 40% in the study by Harradine.[20] Unfortunately, the extraction rate was not mentioned in the study by Eberting et al.[18] This higher extraction rate by Harradine may reflect a more complex series of cases in that sample, but because PAR index was not recorded in this study, it could not be compared.

Alternatively, the different extraction rates may simply reflect a differing treatment approach. The average treatment time in the office of the author (Dr Miles) using a conventional twin bracket (average 15.4 months SD 4.2 months) is shorter than the reduced times reported by both Harradine and Eberting (19–25 months) using the Damon SL bracket. This supports the possibility that the reduction in treatment times by Harradine and Eberting are due to a change to more efficient treatment systems other than using a different bracket. Alternatively, average cases may not respond any differently to SL brackets but more severely crowded cases and extraction cases may. As treatment times get shorter, then perhaps any effect of SL braces in reducing treatment times diminishes. Finally, there may be no real difference and any time savings may be because of other factors such as altered mechanics or unintentional bias.

## CONCLUSIONS Return to TOC

- The Damon 2 bracket was no more effective at reducing irregularity than the conventional twin bracket with elastomeric ligation.
- The Damon 2 brackets were initially less painful than the conventional twin bracket but were more painful when tying in the second archwire.
- Significantly more Damon 2 brackets debonded during the study.

## REFERENCES Return to TOC

1. Andreasen GF, Quevedo FR. Evaluation of frictional forces in the 0.022 × 0.028 edgewise bracket in vitro. *J Biomech.* 1970; 3:151–160. [PubMed Citation]

2. Frank CA, Nikolai RJ. A comparative study of frictional resistance between orthodontic bracket and arch wire. *Am J Orthod.* 1980; 78:593–609. [PubMed Citation]

3. Huffman D, Way DC. A clinical evaluation of tooth movement along archwires of two different sizes. *Am J Orthod.* 1983; 83:453–459. [PubMed Citation]

4. Peterson L, Spencer R, Andreasen G. A comparison of friction resistance for Nitinol and stainless steel wire in edgewise brackets. *Quintessence.* 1982; 5:563–571.

5. Kusy RP, Whitley JQ, Mayhew MJ, Buckthal JE. Surface roughness of orthodontic arch wire via laser spectroscopy. *Angle Orthod.* 1988; 58:33–45. [PubMed Citation]

6. Bednar JR, Gruendeman GW, Sandrik JL. A comparative study of frictional forces between orthodontic brackets and arch wires. *Am J Orthod Dentofacial Orthop.* 1991; 100:513–522. [PubMed Citation]

7. Cacciafesta V, Sfondrini MF, Scribante A, Klersy C, Auricchio F. Evaluation of friction of conventional and metal-insert ceramic brackets in various bracket-archwire combinations. *Am J Orthod Dentofacial Orthop.* 2003; 124:403–409. [PubMed Citation]

8. Ireland AJ, Sheriff M, McDonald F. Effect of bracket and wire composition on frictional forces. *Eur J Orthod.* 1991; 13:322–328. [PubMed Citation]

9. Kusy RP, Whitley JQ. Frictional resistance of metal-lined ceramic brackets versus conventional stainless steel brackets and development of 3-D friction maps. *Angle Orthod.* 2001; 71:364–374. [PubMed Citation]

10. Berger JL. The influence of the SPEED bracket's self-ligating design on force levels in tooth movement: a comparative in vitro study. *Am J Orthod Dentofacial Orthop.* 1990; 97:219–228. [PubMed Citation]

11. Cacciafesta V, Sfondrini MF, Ricciardi A, Scribante A, Klersy C, Auricchio F. Evaluation of friction of stainless steel and esthetic self-ligating brackets in various bracket-archwire combinations. *Am J Orthod Dentofacial Orthop.* 2003; 124:395–402. [PubMed Citation]

12. Taylor NG, Ison K. Frictional resistance between orthodontic brackets and archwires in the buccal segments. *Angle Orthod.* 1996; 66:215–222. [PubMed Citation]

13. Edwards GD, Davies EH, Jones SP. The ex vivo effect of ligation technique on the static frictional resistance of stainless steel brackets and archwires. *Br J Orthod.* 1995; 22:145–153. [PubMed Citation]

14. Hain M, Dhopatkar A, Rock P. The effect of ligation method on friction in sliding mechanics. *Am J Orthod Dentofacial Orthop.* 2003; 123:416–422. [PubMed Citation]

15. Rock WP, Wilson HJ. The effect of bracket type and ligation method upon forces exerted by orthodontic archwires. *Br J Orthod.* 1989; 16:213–217. [PubMed Citation]

16. Thorstenson GA, Kusy RP. Effects of ligation type and method on the resistance to sliding of novel orthodontic brackets with second-order angulation in the dry and wet states. *Angle Orthod.* 2003; 73:418–430. [PubMed Citation]

17. Voudouris JC. Interactive edgewise mechanisms: form and function comparison with conventional edgewise brackets. *Am J Orthod Dentofacial Orthop.* 1997; 111:119–140. [PubMed Citation]

18. Eberting JJ, Straja SR, Tuncay OC. Treatment time, outcome, and patient satisfaction comparisons of Damon and conventional brackets. *Clin Orthod Res.* 2001; 4:228–234. [PubMed Citation]

19. Stolzenberg J. The Russell attachment and its improved advantages. *Int J Orthod Dent Children.* 1935; 21:837–840.

20. Harradine NWT. Self-ligating brackets and treatment efficiency. *Clin Orthod Res.* 2001; 4:220–227. [PubMed Citation]

21. Shivapuja PK, Berger J. A comparative study of conventional ligation and self-ligation bracket systems. *Am J Orthod Dentofacial Orthop.* 1994; 106:472–480. [PubMed Citation]

22. Sims APT, Waters NE, Birnie DJ, Pethybridge RJ. A comparison of the forces required to produce tooth movement in vitro using two self-ligating brackets and a pre-adjusted bracket employing two types of ligation. *Eur J Orthod.* 1993; 15:377–385. [PubMed Citation]

23. Pizzoni L, Raunholt G, Melsen B. Frictional forces related to self-ligating brackets. *Eur J Orthod.* 1998; 20:283–291. [PubMed Citation]

24. Damon DH. The rationale, evolution and clinical application of the self-ligating bracket. *Clin Orthod Res.* 1998; 1:52–61. [PubMed Citation]

25. Henao SP, Kusy RP. Evaluation of the Frictional resistance of conventional and self-ligating bracket designs using standardized archwires and dental typodonts. *Angle Orthod.* 2004; 74:202–211. [PubMed Citation]

26. Berger J, Byloff FK. The clinical efficiency of self-ligated brackets. *J Clin Orthod.* 2001; 35:304–308. [PubMed Citation]

27. Little R. The irregularity index: a quantitative score of mandibular anterior alignment. *Am J Orthod.* 1975; 68:554–563. [PubMed Citation]

28. Miles PG, Weyant RJ. A clinical comparison of two chemically-cured adhesives used for indirect bonding. *J Orthod.* 2003; 30:331–336.

29. Miles PG, Weyant RJ. A comparison of two indirect bonding adhesives. *Angle Orthod.* 2005; 75:1019–1023.

**TABLES** Return to TOC

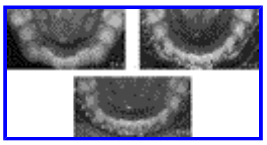
**TABLE 1.** Results of Wilcoxon Signed Rank Test for Comfort and Breakage Data

| Variable | n | Percent | *P* value |
|---|---|---|---|
| Pain days 1–2 Damon 2 | 2 | 3.4 | .04 |
| Pain days 1–2 Standard | 9 | 15.5 | |
| Discomfort on lips Damon 2 | 10 | 17.2 | .11 |
| Discomfort on lips Standard | 4 | 6.9 | |
| Preferred appearance Damon 2 | 0 | 0.0 | <.0005 |
| Preferred appearance Standard | 14 | 24.1 | |
| Pain untying Damon 2 | 7 | 12.1 | .56 |
| Pain untying Standard | 5 | 8.6 | |
| Pain tying in Damon 2 | 21 | 36.2 | .004 |
| Pain tying in Standard | 6 | 10.3 | |
| Loose brackets Damon 2 | 26 | 9.2 | <.0005 |
| Loose brackets Standard | 5 | 1.8 | |

**TABLE 2.** Irregularity Index (II) Results with Wilcoxon Signed Rank Test

| Variable | Irregularity Index (mm) | *P* value |
|---|---|---|
| Irregularity index T = 0 Damon 2 | II = 2.0 | .98 |
| Irregularity index T = 0 Standard | II = 2.1 | |
| Irregularity index T = 1 Damon 2 | II = 0.9 | .001 |
| Irregularity index T = 1 Standard | II = 0.7 | |
| Irregularity index T = 2 Damon 2 | II = 0.7 | .001 |
| Irregularity index T = 2 Standard | II = 0.5 | |

**FIGURES** Return to TOC



Click on thumbnail for full-sized image.

**FIGURE 1.** An example of the average response at baseline (T = 0), alignment after 10 weeks (T = 1) with the 0.014-inch Damon 2 copper NiTi archwire, and after another 10 weeks (T = 2) with the 0.016 × 0.025-inch Damon 2 copper NiTi archwire. Damon 2 is on the patient's left side and the conventional twin bracket with module ligation on the patient's right

[a]Private practice, Caloundra, QLD, Australia

[b]Chair, Dental Public Health and Head, Division of Pediatric & Developmental Dental Sciences, School of Dental Medicine, University of Pittsburgh, Pittsburgh, Pa

[c]Research Assistant, Dental Public Health, School of Dental Medicine, University of Pittsburgh, Pittsburgh, Pa

Corresponding author: Peter G. Miles, 10 Mayes Avenue, Caloundra, QLD 4551, Australia (E-mail: pmiles@beautifulsmiles.com.au)