

***A comparative study of canine distalization using interactive edgewise twin brackets and conventional edgewise single brackets: clinical study.***

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Several bracket designs have been engineered to diminish the friction of contact between bracket, arch wire, and ligature. Independent researchers such as Kapur, Sinha, and Nanda<sup>1</sup> have concluded that interactive brackets (i.e. self-ligating brackets) have lower kinetic frictional forces when compared with conventional brackets ligated to the wire by means of steel ligature or elastomeric rings. Their results corroborate the findings of previous studies such as Vourmouris<sup>2,3</sup> and offer an alternative approach to bracket design that could provide substantial advantage in sliding mechanics.

Specifically, this investigation compared differences in mechanical resistance to mesiodistal orthodontic forces between interactive edgewise twin brackets (IETB)<sup>\*1</sup>

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<sup>\*1</sup> Damon SL. Slot 0.018"X0.025" Trademark of Ormco/"A" Company Orthodontics, 1717 W. Collins Ave., Orange, CA 92667

Figure no.1) and conventional edgewise single orthodontic brackets (CESB<sup>\*2</sup> Figure no.2). This article provides clinical observation and statistical evaluation of the performance offered by both systems in sliding canines distally when the dental extraction of maxillary and/or mandibular first bicuspid is required (Figures no.3 and 4). This study was designed to compare the rates of movement of teeth utilizing interactive versus traditional edgewise bracket designs. Since the use of elastomeric chains to translate canines during retraction is common in clinical circumstances, it was decided to implement the same system of retraction in this study. Although the Damon Technique does not generally advocate the use of elastomeric chains for cuspid retraction, this project was based on the premise that the use of elastomeric chains offers the possibility of comparing two brackets' mechanisms within the same arch. The use of wires, as advocated by Dr. Damon, to direct the force of retraction, represent an unsuitable mechanism for purposes of direct comparison of brackets' frictional resistance. This investigation is also one of the first *in vivo* studies comparing the direct performance of different bracket designs under the same clinical circumstances. It should therefore be understood that this is a study comparing IETB and CESB designs. It is in no way an evaluation of the efficiency or effectiveness of the systems or philosophies with which the individual brackets are associated.

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<sup>\*2</sup> Mini Wick Alexander. Slot 0.018"x0.025" Trademark of Ormco/"A" Company Orthodontics, 1717 W. Collins Ave., Orange, CA 92667

## Materials and Methods

The subjects of this sample are 10 individuals with a total of 26 extraction sites for comparison. The cases were selected from the files of a private orthodontic practice. In each case, an IETB<sup>\*1</sup> and a CESB<sup>\*2</sup> were placed on upper and/or lower canines of the same individual. In order to minimize additional environmental factors that might influence the performance of the canine retraction assemblies, a “split mouth” study design was employed: i.e. the same system of brackets was placed on the same side (right or left) while the other system of brackets was placed on the contralateral side (Figures no. 5, 6).

A total of 13 IETB and 13 CESB, with a 0.018" X 0.025" slot on both systems, were tested. During the first phase, canine brackets were bonded<sup>\*3</sup> and the leveling stage was completed using 0.016" nickel-titanium wires.<sup>\*4</sup> In the second phase, the application of a distal force was applied to each canine until the accomplishment of the desired retraction was achieved. An effort was made to provide the same amount of force to the different systems by measuring the force with a force gauge<sup>\*5</sup>. The forces employed ranged between 75-85 grams of force (gmf). For each retraction assembly, no other ligation system was employed other than an elastomeric chain. During the retraction of cuspids, 0.016" stainless steel archwires<sup>\*4</sup> with tie backs mesial to first molars were used. Dental casts and intraoral photographs were

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\*3 Rely-A-Bond bracket adhesive, Reliance Orthodontic products, Inc., Itasca, IL.

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taken before starting the retraction stage and during each consecutive appointment involving the implementation of distalizing forces. Individualized anatomic landmarks designated on patients' casts were used in order to measure the distance between canines and second bicuspids or first molars. The sets of casts were archived in order to create a systematized, reliable, long-term reference of comparison. Distances were measured directly on the working casts with metal-tipped calipers. Such distance was then transferred and measured with a Boley gauge<sup>\*5</sup> accurate to one tenth of a millimeter. Factors such as force applied to the systems through elastomeric chains and timing for canine movement and distance were recorded by a single operator on each appointment. As a secondary objective, clinical manipulations that might affect retraction patterns were compared. Therefore, selective elastomeric chain placement was used to provide different friction levels within the same biomechanical system. Elastomeric chains at forces of 75-85 gm<sup>f4</sup> were engaged to the ball-hook of the IETB in order to create a low frictional resistance setting. In a subgroup of IETB the elastomeric chain was engaged to the four wings of the bracket, representing a high friction mechanism. In all cases, the CESB were engaged with the elastomeric chain surrounding the single wings.

The statistical analysis featured a series of t-tests conducted to evaluate the significance of differences between mean values of time and distance among the systems. Average tooth speed was recorded in millimeters per month of treatment. The following tables of correlation, Table number 1 and Chart number 1, compare the distance achieved over time.

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## Results

Two out of twenty-six observations were not considered for analysis due to discharged elastomeric chains (e.g. broken chains or chains that were not longer engaged on the bracket when it should have been) and inconsistent patterns of retraction. Table No.1 shows the total number of observations considered (n=24, observation 3a was discounted), whether upper or lower cuspids were involved, and specifying which part of the bracket was engaged in the retraction assemblies (wings or hooks). Table 1 also shows the existing distance at the beginning of the retraction phase, the final position relative to anatomic dental references, total amount of millimeters traveled by the different brackets' systems, and total amount of days it took to accomplish the desired position. On case 3b the lower canines arrived to a position that was unsatisfactory for the overall orthodontic treatment objectives. The retraction of the lower cuspids was suspended at a certain point and continued months later ( 2 phases of retraction). Therefore, it was not included in certain analysis. Cases 9a and 9b showed small distances to be traveled by the canines with IETB brackets. This was due to the fact that after the leveling phase was completed, a major distal drifting was observed on the side where IETB were used. We included this observation in the analysis because the distal drifting observed translates into the presence of lower friction. Table No. 1 shows that if the IETB is completely engaged with the elastomeric chain surrounding the brackets' wings, there is no significant difference in time required to accomplish a predetermined position (Figure no. 7.1, 7.2, 8, 9). It was observed from the intraoral photographs that single brackets present

poor tridimensional control as evidenced by the presence of rotations in the canines being retracted. The discrepancies can be observed during the retraction process in Figures 7.2 and 8. The photos clearly show that the rotation associated with retraction was far greater with the CESB than with the IETB, a consistent finding throughout the study. The lack of stability between the bracket and arch wire tended to increase the friction present in the system.

**TABLE #1: Treatment Summary**

Case #	Cuspid (U/L)	Hook / Wings	Force min	Force max	Distance (mm)						End date				
					Start:		Finish:		Dist:		Start date		End date		
					IETB	CESB	IETB	CESB	IETB	CESB	IETB	CESB	IETB	CESB	days.
1 U	w		75	85	13.1	13.1	7.1	7.8	6	5.3	10/5/00	1/17/01	1/17/01	104	104
2 U	w		75	85	23.1	22.2	13.4	14.8	9.7	7.4	8/1/00	12/4/00	12/4/00	125	125
3b L	h		75	75	13.3	15	8.2	8.9	5.1	6.1	7/19/00	11/29/00	11/29/00	133	133 *
4 U	w		75	85	10.1	8.9	7.1	7.3	3	1.6	11/16/00	2/26/01	2/26/01	102	102
5 U	w		85	85	11.9	11.9	7.2	7.7	4.7	4.2	11/13/00	3/1/01	3/1/01	108	108
6 U	h		75	85	15.1	15	7	8	8.1	7	8/31/00	12/12/00	3/13/01	103	194
7 U	w		75	85	14.1	16.2	8.4	8.7	5.7	7.5	10/17/00	3/20/01	4/25/01	154	190
8 U	h		75	85	14.4	14.4	7	8.3	7.4	6.1	10/3/00	3/15/01	5/17/01	163	226
9a U	h		75	85	9.8	14	6.8	7.5	3	6.5	11/9/00	12/12/00	1/22/01	33	74 **
9b L	h		75	85	9.4	11.1	7.4	6.3	2	4.8	1/22/01	3/20/01	5/15/01	57	113 **
10a U	h		75	85	13.4	14.1	7.9	8.2	5.5	5.9	10/10/00	1/15/01	4/17/01	97	189
10b L	h		75	85	12.2	13.1	7.3	7.6	4.9	5.5	12/11/00	2/13/01	4/17/01	64	127

**Table No.1 showing 24 extraction sites, 18 upper sites and 6 lower sites, distance traveled and days involved. Elastomeric chain engaged either at the ball-hooks (h) or wings of the brackets (w).**

Table No.2 displays percentage of time saved from overall retraction time spent. The t-test result of 5.351 provides a certainty of 99.5% to the analysis. Five out of six observations suggest that the amount of time required by IETB is almost half the total amount of time required by the CESB to reach the desired tooth position.

**TABLE #2: Time Saved, by % Comparison**

Case #	IETB	CESB	% of time saved by IETB
6	103	194	0.469
8	163	226	0.279
9a	33	74	0.554
9b	57	113	0.496
10a	97	189	0.487
10b	64	127	0.496
		Mean	0.463
		St. Dev	0.087
		Mean/StDev	5.351

Table No. 2 Time saved by percentage of comparison from overall retraction phase.

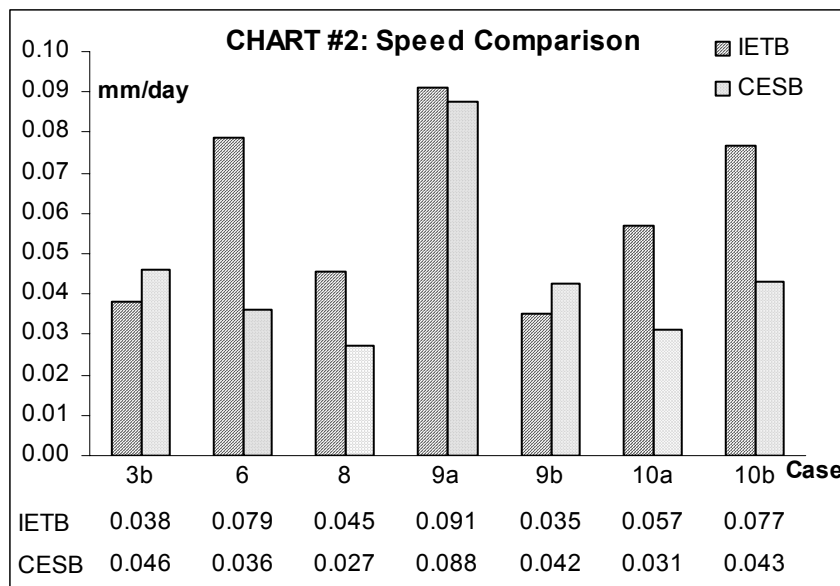
Speed superiority of the IETB is established in Table No. 3 with a Mean/StDev ratio of 2.889. Data in Tables 1 and 2 provide the primary findings in the study as they clearly show the major degree of disparity between the two brackets' performances. Since the distance traveled in a determined period of time was measured, we could calculate the average speed in which the canines were moving ( $V= d/t$ ).

**TABLE #3: Speed Comparison**

Case #	IETB	CESB	IETB/CESB
	IETB Speed	CESB Speed	Speed
3b	0.038	0.046	0.8
6	0.079	0.036	2.2
8	0.045	0.027	1.7
9a	0.091	0.088	1.0
9b	0.035	0.042	0.8
10a	0.057	0.031	1.8
10b	0.077	0.043	1.8
Sum	0.422	0.314	10.143
n	7	7	7
Mean	0.060235	0.044825	1.448967
		St. Dev	0.501388
		Mean/StDev	2.889908

**Table No.3. Speed comparison between IETB and CESB.**

Chart No. 1 represents the total amount of millimeters per day on a case- by- case basis. Five out of seven cases demonstrated a speed superiority of the canines being translated using the IETB.



**Chart No. 1. Speed comparison between IETB and CESB. Notice the disparities between observations in a total of 7 cases with 14 extraction sites.**

Chart No. 2, the top of each bar is the total time required for the retraction phase. Each bar includes both IETB and CESB. The striped portion of the bar is the time the IETB required, and the dotted portion represents the **additional time** that the CESB needed in order to achieve the desired tooth position. It can be observed that cases in which the elastomeric chain was engaged directly to the ball-hook of the IETB, the desired position was accomplished in almost half of the time required by a CESB with the elastomeric chain surrounding the bracket's wings. This observation is complemented with clinical pictures depicting IETB to which the elastomeric chain was engaged solely to the ball-hooks (Figures no. 10.1-10.3, 11.1-11.3, 12.1, 12.2, 13.1, 13.2).

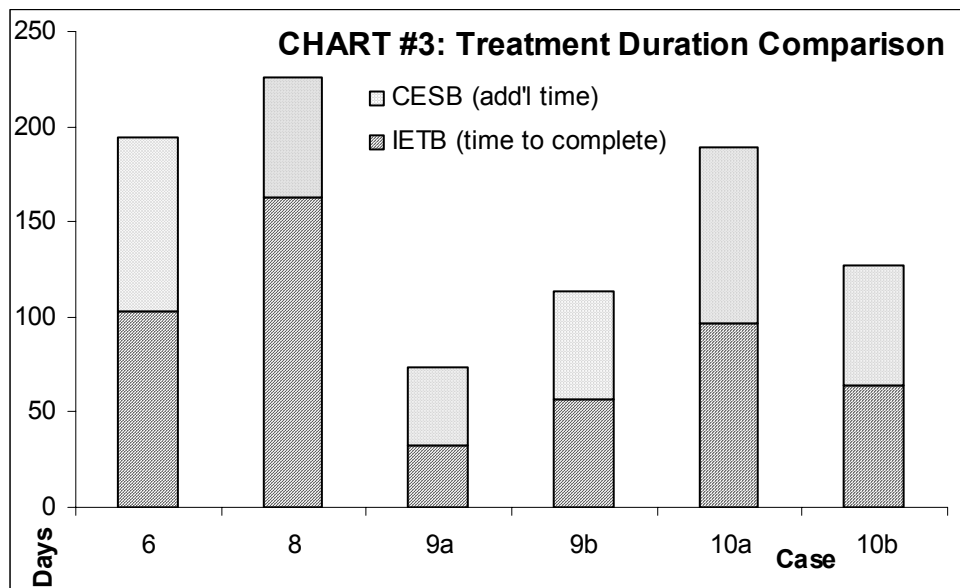


Chart No. 2. Retraction duration comparison. Observe the added time required to accomplish the retraction phase while using CESB.

## Discussion

The causative factors of these clinical and statistical observations could be correlated to major differences in bracket design and the unique characteristics among the systems involved in this research. The dramatic contrast in treatment time was driven by the modification in elastomeric engagement used in the two systems of retraction. These descriptive statistics could be explained in light of two basic principles. First, the ligation technique significantly influences the amount of friction present in the interrelationship of bracket, wire, and means of engagement. Second, as a tooth is translated with sliding mechanics, it is a well known fact<sup>5,6,7</sup> that tipping will occur at the crown level, contributing to the overall friction present in the system. Resistance to sliding increases linearly as the angulation of the wire across the bracket slot increases<sup>8,9</sup>. Edgewise single brackets also provide poor tridimensional control. We observed mesiodistal tipping and rotation with the single brackets, which added frictional resistance and hindered tooth movement. What must be considered before drawing conclusions concerning efficiency in controlling tipping and rotations in any bracket system is actual bracket position. A poorly placed bracket ( i.e. one not parallel to the long axis of the tooth ) can obviously create iatrogenic tipping independent of bracket design. A follow-up study relative to tipping will be to take photographs to record bracket position and radiographs to observe tipping. Radiographs of tipped teeth alone without visual records of bracket's position, will not provide conclusive evidence. We observed clinically a more rigid binding effect on the wire while using elastomeric ligation; such observation might account for increased friction in the bracket, wire, and ligation triad. Since a low level of force was chosen for both systems, such a level might not be enough to overcome the friction generated by the

triad in the CESB cases, slowing movement and requiring more time to reach completion. With less frictional drag in the interactive system (IETB), it would follow that there could be a more rapid tooth movement with a light force mechanism of retraction. The present results corroborate findings by authors who have suggested that resistance to displacement is substantially influenced by the perpendicular component of the bracket-to-wire contact force.

## **Conclusion**

This investigation produced scientific and clinical evidence that would lead to the following conclusions:

1. The location of elastomeric chain engagement significantly influenced the performance of tooth movement. Single edgewise brackets tied directly to their wings with an elastomeric chain favor the presence of high deflection moments that would lead to rotations, mesiodistal tipping and increased friction showing a slower retraction movement.
2. The reduced frictional resistance in interactive edgewise twin brackets is associated with low frictional coefficients of the sliding arm that interfaces minimally with the arch wire. The interactive design offers a reduced seating force friction in comparison to conventional ligating mechanisms in which an increased wire deflection adds overall friction in the assembly triad.

3. Interactive brackets permit consistent light force application that is clinically effective for canine retraction. Interactive mechanisms significantly reduce overall cuspid retraction time when compared to conventional edgewise single brackets.

### **References**

1. Kapur R, Sinha PK, Nanda RS. Frictional Resistance of the Damon SL Bracket. *J Clin Orthod* 1988;8:485-489.
2. Voudouris JC. Interactive edgewise mechanisms: Form and Function comparison with conventional edgewise brackets. *Am J Orthod Dentofac Orthop* 1997;111:119-140.
3. Berger JL. The influence of the SPEED bracket's self-ligating design on force levels in tooth movement: a comparative study. *Am J Orthod Dentofac Orthop* 1990;97:219-28.
4. Natras C, Ireland AJ, Sherriff M. An Investigation into the Placement of Force Delivery Systems and the Initial Forces Applied by Clinicians during Space Closure. *Br J Orthod* 1997;24:127-131.
5. Bednar JR, Gruendeman GW, Sandrik JL. A comparative study of frictional forces between orthodontic brackets and arch wires. *Am J Orthod Dentofac Orthop* 1991;100:513-22.

6. Frank CA, Nikolai RJ. A comparative study of frictional resistances between orthodontic bracket and archwire. *Am J Orthod Dentofac Orthop* 1980; 78:593-609.
7. Articulo LC, Kusy RP. Influence of angulation on the resistance to sliding in fixed appliances. *Am J Orthod Dentofac Orthop* 1999; 115:39-51.
8. Proffit WR, Fields HW. *Contemporary Orthodontics*. St. Louis: Mosby; 2000.
9. Graber TM. *Orthodontics Current Principles and Techniques*. St. Louis: Mosby; 2000.

## **Photographs' captions**

Figure No.

1. Interactive Edgewise twin bracket (IETB)
2. Conventional edgewise single orthodontic bracket (CESB)
3. Extraction sites of maxillary canines ( Reference case 10a )
4. Extraction sites of mandibular canines (Reference case 10b )
5. Right side with CESB on upper and lower canines. Leveling phase with 0.016" nickel-titanium wires. (Reference case 10a, 10b )
6. Left side of patient in fig. no. 3, IETB on upper and lower canines. Leveling phase with 0.016" nickel-titanium wires. (Reference case 10a, 10b )
- 7.1 Beginning of retraction phase with elastomeric chain engaged to the wings of the CESB. ( Reference case 7 )
- 7.2 Beginning of retraction phase with elastomeric chain engaged to the wings of the IETB. Contralateral side of patient in fig. no. 5.1. (Reference case 7)
8. End of retraction phase of patient in fig. no. 5.1. Both brackets' designs achieved the desired position almost at the same time. Notice the major degree of distal rotation present on the cuspid with CESB. ( Reference case 7 )
9. End of retraction phase in a different patient. Both designs of brackets had its wings surrounded by the elastomeric chain. The desired canine position was accomplished almost at the same time with major presence of distal rotation in the side of the CESB. ( Reference case 10a )

10.1 Initial retraction phase. Upper right canine with IETB and elastomeric chain engaged to the ball- hook of the bracket. ( Reference case 6 )

10.2 Initial retraction phase. Upper left canine of patient in fig. no. 8.1 with CESB. Elastomeric chain engaged to the wings of the bracket. ( Reference case 6 )

10.3 Occlusal view of patient in fig. no. 8.1. Beginning of retraction phase. ( Reference case 6)

11.1 End of retraction for the right canine of patient showed in fig. no. 8.1 The canine with the IETB has achieved the desired position. ( Reference case 6 )

11.2 Canine in the left side of patient in fig. 8.2 continues to be retracted. Notice that a significant distance is still to be traveled. ( Reference case 6 )

11.3 Occlusal view of patient in fig. 8.3. ( Reference case 6 )

12.1 IETB engaged only to the ball-hook during the retraction phase (Reference case 3b)

12.2 Occlusal view of patient in fig. no. 10.1 showing different retraction patterns. The cuspid on the right side with an IETB and elastomeric chain to the ball-hook of the bracket moved faster than the left cuspid with and CESB and fully engaged wings. (Reference case 3b)

13.1 Lower left cuspid with IETB and elastomeric chain to the ball-hook of the bracket during retraction phase. ( Reference case 10b)

13.2 Occlusal view of patient in fig. no. 11.1 showing faster movement for canine on the left side. (Reference case 10b )

