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A Comparison of Indirect Lingual Bracket Placement by Practitioners and a Commercial Laboratory as it Relates to Crown Torque

Randy E. Buchmiller

Abstract

A COMPARISON OF INDIRECT LINGUAL BRACKET PLACEMENT
BY PRACTITIONERS AND A COMMERCIAL LABORATORY
AS IT RELATES TO CROWN TORQUE

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Four sets of patient models were selected from the eighty cases Ormco Corporation used in the development of their lingual bonded appliance. These four sets of models were duplicated and identical sets of four models were sent to each practitioner and the laboratory. The practitioners and the laboratory were to position the lingual brackets on the models from second bicuspid to second bicuspid upper and lower and return them to Loma Linda University Department of Orthodontics for evaluation.

The laboratory chosen for placement of the brackets was the Ormco laboratory in Glendora, California. The laboratory ran these four cases through in their normal fashion to simulate clinical conditions. The practitioners were divided into two groups for evaluation, experienced and inexperienced.

Three experienced lingual practitioners were chosen from the Ormco Corporation Lingual Task Force and four inexperienced lingual practitioners were chosen from the faculty and alumni of Loma Linda University.

The four sets of models from the laboratory and the seven practitioners were sectioned per tooth and photographed with the use of a custom jig and a 35mm camera with a macro lense. The film was processed in slide format and measurements were made using method modified from that described by Dr. Andrews of "A" Company. The data was submitted to the Department of Biostatistics of Loma Linda University for computer analysis. The measured crown torque was compared to the torque prescription of the Ormco lingual bonded appliance. It was found that there were no significant statistical differences in any of the placements. Although, the calculation of the mean absolute torque difference did allow us to rank the laboratory and the practitioners. The ranking showed an experienced practitioner first, an inexperienced practitioner second, and the laboratory third.

LOMA LINDA UNIVERSITY

Graduate School

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Each person whose signature appears below certifies that this thesis, in his opinion, is adequate, in scope and quality, as a thesis for the degree of Master of Science.

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INTRODUCTION

With the great upswing in adult orthodontics, one of the newest areas of interest is the lingual appliance. In the development of this appliance many areas of clinical importance were thoroughly researched. Some of these aspects of research are speech problems, patient comfort, patient selection, oral hygiene, bracket size and direct versus indirect bonding of the lingual brackets. 2,9,17 Although it has been suggested that, for proper bracket placement on the lingual surface of a tooth, the indirect method of bracket placement is preferred, 19 it has not been studied whether a commercial laboratory or the individual orthodontic practitioner can place the lingual brackets more accurately. This paper will deal specifically with the torque translated to the tooth as determined by the accuracy of placement of the lingual bracket.

The field of orthodontics has traditionally involved the adolescent period; today's society displays an increased trend for personal esthetics. This trend for personal appearance improvement has brought the adult segment of the population to seek orthodontic care and, consequently, new methods of adult patient treatment are constantly sought. At one point in the quest for "invisible" braces the clear plastic bracket was considered but was soon discarded due to fracture, discoloration and lack of torque control. 2,14,17 Removable orthodontic appliances such as the Crozat have also been considered but were also discarded by most practitioners because of their adjustment difficulty and reliance on patient cooperation. Many other appliances were used

and it was only with the advent of bonding that a new appliance system, based on bonding, was able to be developed and possessed properties in which the advantages outweighed the disadvantages.

Many advances in bonding, including better adhesives and bracket pads, have led us to consider which way is best to place the directly bonded appliances on the teeth. In the early labial surface bonding it was felt that the direct bond placement was superior to indirect placement due to the greater failure rate of indirectly bonded brackets without a greater accuracy in positioning of the bracket. 11,23,24 The failure rate was thought to be higher for the indirect method because the tray fabricated to position the brackets did not allow the bracket pad to be fitted closely enough to the dental surface to create a stronger bond. 23,24 The direct method had the added benefit of better cleaning of the adhesive flash around the pad and a resulting lower frequency of gingival irritation. 11,23,24 In a more recent study it was shown that there is very little clinical difference in bracket positioning and bond failure between the direct and indirect bracket placement methods. 1,22

One of the major problems with the lingual appliance is the increase in chair time needed to make compensating bends to the archwire which are much harder to accomplish due to the decreased interbracket distance of lingual tooth surfaces, therefore bracket placement accuracy should decrease the length of chair time needed. Why is the indirect method suggested as the preferred method when placing the lingual brackets? The variation and irregularity of lingual tooth surface morphology make it necessary to contour the bracket bases to develop the correct bracket

base thickness and torque. 2,3,7,19 Secondly, it is very difficult for the practitioner to visualize the correct bracket slot heights and angulations and how these heights and angulations relate to the more uniform labial surface. 7,19 In addition, it is difficult for the practitioner to obtain a direct line of sight for the direct bonding of lingual surfaces.

From the previous discussion it was felt that it would be worth evaluating the performance of a commercial laboratory in the preparation of a transfer tray for the indirect placement of the lingual brackets. This study will evaluate the performance of a commercial laboratory versus the orthodontic practitioner in the placement of the lingual brackets on a study model. Specifically, this paper will deal with the torque and determine who places the bracket most accurately on the lingual surface of a tooth to deliver the torque that was designed into the lingual bracket.

METHODS AND MATERIALS

Four non-extraction cases were selected from eighty cases which Ormco used in the development of their lingual bonded appliance. The criteria for selection was: 1) all permanent teeth were present from first molar to first molar in both dental arches, 2) adequate crown length for all the teeth to allow placement of the bonds, 3) no rotations would affect the correct placement of the bonds, and 4) the occlusal surfaces were in adequate condition so the judgment in the positioning of the bonded bracket would not be affected.

The laboratory placement of the brackets was provided by the Ormco Corporation laboratory in Glendora, California which specializes in the indirect lingual bond placement. The cases were processed by the lab in their normal fashion and were not all done by the same technician. The reason for varied technicians was to simulate normal service of the laboratory.

The selected orthodontic practitioners were divided into two groups. One group was composed of three orthodontists who had clinical experience in the use of the lingual appliance; these three orthodontists were selected from the lingual task force of Ormco Corporation. The second group was composed of four orthodontists who had little or no clinical experience with the lingual appliance; however, they had taken the Ormco lingual seminar. Four orthodontists were selected from the faculty and alumni of Loma Linda University Department of Orthodontics.

Each of the orthodontists and the laboratory was supplied with the same four sets of patient models. The models were similar; however, they were selected from four different patients. They also received an information sheet on the correct placement of the bonds, four sets of lingual bonds, and some epoxy adhesive (fast set) for placement of the bonds. All the models were given a key tooth, which was marked in red. The key tooth was the right central incisor, both upper and lower. The first bond was to be placed on the key tooth and then used as a guide to the placement of the remaining bonds. Each orthodontist and the laboratory were to place the bonds from second bicuspid to second bicuspid, upper and lower on all four sets of patient models and return them to Loma Linda Department of Orthodontics for evaluation.

The first step in the evaluation was numbering and sectioning the teeth from the models. The teeth to be evaluated were numbered from 4-13 (upper) and 20-29 (lower) which conforms to the numbering system used in operative dentistry. The second step was to photograph the teeth. The photographs were taken on a custom-made jig, which included a 35 mm camera with a macro lens (see Fig. 1). The tooth was held in the jig by two metal blades which fit precisely into the bracket slot. The photographs were taken from the proximal surface (Fig. 2). The film was processed by a commercial processing laboratory in the color slide format. The third step was that of tracing the buccolingual profile of the teeth. The tracing was done on tracing acetate. The slides were viewed on a Kodak Caramate slide viewer and the tracings done directly off the screen. A line which was parallel to the bracket slot was also traced at this time (Fig. 3). The fourth step was the torque

measurement on the tracings of the teeth. This was done by locating the LA point (midpoint of the facial surface) and drawing a line tangent to the facial surface at the LA point. The LA point and the tangent line were drawn on all the teeth done by the Ormco laboratory. The corresponding teeth from the cases of the other participants were then superimposed over the Ormco teeth and the same tangent line was drawn. When all the tangent lines were drawn the torque was measured with an A.T. Baum Cephalometric protractor (Fig. 4). The torque was listed for every tooth in magnitude and direction. Magnitude was expressed in degrees and direction as + or - . The + direction was lingual root torque and the - direction was buccal root torque. The fifth step was the comparison of the torque that was supposed to be delivered to the tooth by the correct placement of the bracket and that which was actually delivered to the tooth. The ideal torque for the Ormco lingual bond was similar to the torque described by Dr. Andrews in the original "A" Company straight wire appliance with some additional torque in the anterior teeth. The results were achieved by submitting the measured crown torque data to the Department of Biostatistics of Loma Linda University for computer analysis. The computer analysis consisted of calculation of the absolute difference in crown torque, mean, standard deviation analysis of variance, paired t-tests, and a ranked sum test.

RESULTS

The measured crown torque from the four sets of patient models consisted of eighty torque measurements for each practioner and laboratory. The eighty torque measurements were entered into the computer from one to eighty starting with model 1 tooth 4, respectively for each practitioner and the laboratory.

The calculation of the difference in crown torque was performed by subtracting the ideal amount of crown torque from the measured amount of crown torque for each tooth. It was decided that the absolute difference be used so that positive and negative differences would not cancel in the calculation of the mean and standard deviation. From the calculation of the mean and standard deviation we were able to rank the laboratory and the practitioners. The lower the mean absolute difference the closer to the ideal was the placement. The ranking showed an experienced practitioner first with an inexperienced second and the laboratory third (See Table IV). A ranked sum test comparing the experienced and the inexperienced was performed resulting in a Z value of 0, which indicates no significant difference between the groups.

An analysis of variance was performed using absolute difference in torque as the dependent variable and person-tooth and practitioner as the independent variable. This analysis showed no significant effect of person-tooth; but for the practitioner there was a highly significant effect at the p=.001 level. A look at Table IV suggests that the small

p-value results because of the low means of practitioner 2 and 7 and the high means of practitioners 5 and 8.

Paired t-tests were performed comparing the experienced and inexperienced practitioners to the laboratory. The results of the paired t-tests showed no significant difference among practitioners although practitioners 5 and 8 had p values of .030 and .015, respectively. The previous p values would be significant if alpha is assumed to be .05; however, for multiple tests the .05 alpha value must be divided by the number of tests. Therefore, the alpha value for significance would be .05/7 or .007 and the p values .030 and .015 do not indicate significance (See Table V).

In conclusion, the results of the statistical analysis showed no significant difference on average between the laboratory and either group of practitioners in the placement of the lingual brackets as they relate to crown torque. The practical implications must be considered because a few misplaced brackets could change the average. In reviewing the means in Tables I,II,III, & V, it should be noted that every group had some extreme deviation from the ideal; therefore, clinically there will be need for some archwire compensations.

DISCUSSION

It has been shown in the data and statistical analysis that the torque on the teeth does not necessarily conform to the lingual bracket prescription; therefore, the intended result does not always occur. It was first believed the sophstication of the laboratory procedure would place the bracket more ideally: however, laboratory placement did not bring about the intended result.

It may be helpful for purposes of discussion to describe the procedures of the Ormco indirect laboratory for placing the lingual bracket. The laboratory is owned and operated by Ormco, a division of Sybron Corporation, and is located in Glendora, California. The laboratory specializes in bracket placement and construction of a transfer tray for indirect bonding of the lingual brackets. When patient models are received by the laboratory, a modified dental surveyor and a torque and angulation reference gauge are used to align the lingual surfaces relative to the labial crown inclinations. 19 Lingual bracket slot heights are first determined, based upon the shortest lingual crown available in both the anterior and the posterior segments. 19 The criteria for bracket placement are: a) the bracket clear the gingival margin by at least 1.5 mm and, b) 2 mm are allowed between the incisal edge and the bracket bite plane on the incisal area of the bracket. 16 The technician then marks the crown's long axis on the labial surfaces. Then he uses the surveyor to transfer it to the

lingual surface. 19 A gauge having the labial torque and angulation specific for each tooth is used to align the axial inclinations relative to the marking stylus on the surveyor. 19 The gauge is placed on the long axis line perpendicular to the labial surface. 19 The stylus, connected to a dilatometer, is then lowered the specified distance, as determined in the initial survey, and a reference mark is made on the model, yielding both bracket slot height and angulation. 19 The bracket base is contoured to the lingual surface and then placed on the model with the bracket slot bisecting the reference mark at the intersection with the long axis line. 19 This placement method as shown by this study is of no significant value in relation to the torque translated to the tooth by the bracket. The value of this method of bracket placement in relation to angulation and vertical bracket slot height is still under investigation.

Logically, one would say, if the vertical position of the bracket slots were equal, then the torque delivered to the contralateral teeth should be equal. In other words, the torque might not be the same as the ideal torque, but they should be equal. This was shown not to be true from the initial data (Tables I,II, & III). The reason for this contradiction in logic is that the lingual anatomy may vary enough between contralateral teeth to make the difference in torque noticeable. 4 It must also be remembered that before impressions for indirect bonding are taken the lingual tooth surfaces are dressed with a rotary instrument to remove large cingulae, rudimentary cusps, and other irregularities on the lingual surfaces. The act of dressing the lingual tooth surfaces in itself may have a direct effect on creating a

difference in crown torque for contralateral teeth. 19 It must also be considered that the contouring and adapting of the bracket pad to the lingual tooth surface may also cause a difference to be noticed in torque to contralateral teeth. These torque differences are quite often seen in the clinical setting. The area that most often displays this is the central incisor area where the teeth are not only contralateral but adjacent; the slot heights are equal but there is a torque difference between the teeth. 15

The torque designed in the bracket by the manufacturer was rarely reproduced in the placement of the brackets by either the laboratory or the practitioner as seen in the initial data (Tables I & II). Diamond states that brackets placed at the same vertical height on the lingual slopes will have different angulations and will be located at various distances from the incisal edge (Fig. 5). The torque is also changed as the bracket slot is moved incisally or gingivally from the ideal position. An example would be the incisor teeth which can be slightly concave on the lingual surface. As the bracket slot is moved gingivally from the ideal position the torque will decrease; and conversely if the bracket slot is moved incisally the torque will be increased. 17

The ideal position for a torqued and angulated lingual bracket is therefore quite nebulous. In labial bonded brackets the sophistication of design is far less critical because the bracket prescription will determine, with correct positioning, the esthetic nature of the result regardless of the varied lingual anatomy. In the lingual bracket approach the bracket prescription must try to align the labial surfaces esthetically by bonding to lingual tooth surfaces which not only vary

per tooth but vary in each individual patient. The difficulty of the lingual approach is therefore quite obvious.

Diamond feels that at this point in the development of the lingual appliance the straight wire approach cannot be relied upon and the orthodontist must make a final decision on torque, tip and in and out. 7 It has been noted by Paige that even with the disadvantages the precise positioning of the teeth becomes more obvious without the distraction of the brackets and wires, and lip posture is seen correctly and not artificially positioned in front of the anterior teeth. 17

When one reviews all the advantages and disadvantages of the lingual appliance it then comes down to a personal decision whether or not to use the lingual appliance. If one decides to do lingual orthodontics, what might be the advantages of the laboratory? The most obvious advantage would be the after-hours time saved in preparation of the indirect tray. It was noted in examination of the practitioner placement in this study that none took the time to adapt the bracket pad to the lingual tooth surface. The laboratory does adapt the bracket pad to the lingual tooth surface. Zachrisson states that inadequate adaptation of the bracket pad to the tooth surface is one of the four major reasons for bond failure. 23 The length of appointments of the lingual appliance are already much longer than the labial appliance so if there were less bond failure with the laboratory procedure it would certainly be an advantage. In conclusion, the laboratory may not be superior to practioner placement but it does provide at least an equivalent result and should be considered.

SUMMARY

The results of the present study on the lingual appliance comparing indirect bracket placement by orthodontic practioners and a commercial laboratory as the placement relates to crown torque showed there was no statistical difference in who placed the brackets. In studying the mean absolute difference in torque for each participant it showed the laboratory third in the ranking with first and second going to experienced and inexperienced practitioners respectively.

The laboratory, though not significantly better, does show some advantages. As to whether the laboratory proved better at slot height and angulation, the results of that study are not finished at this time.

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APPENDICES

FIGURE 1 - Camera with ring flash and custom jig

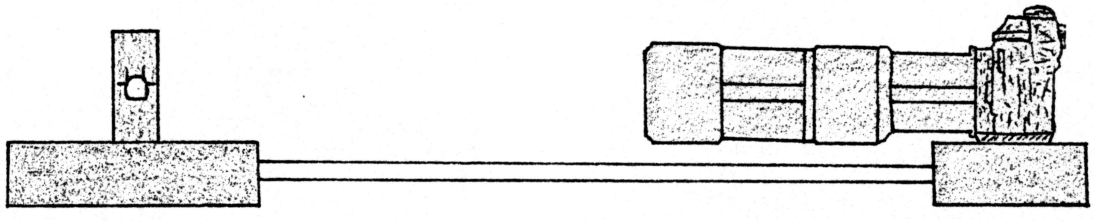


FIGURE 2 - Tooth as photographed on custom jig

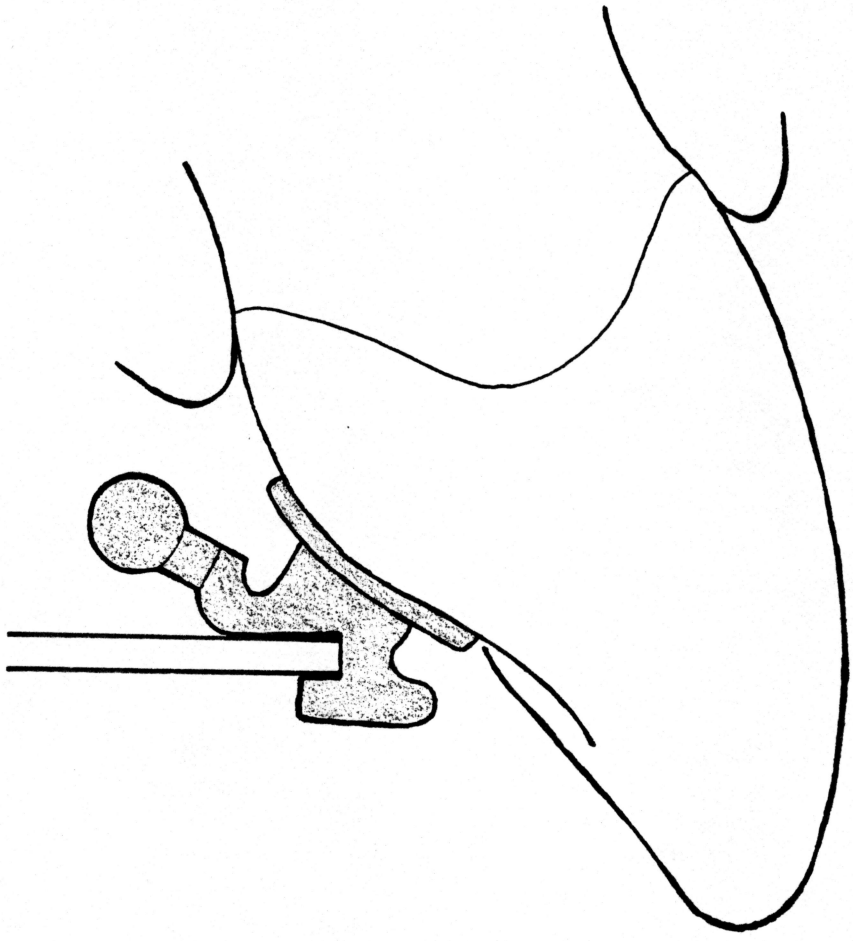


FIGURE 3 - Original tracing from color slide

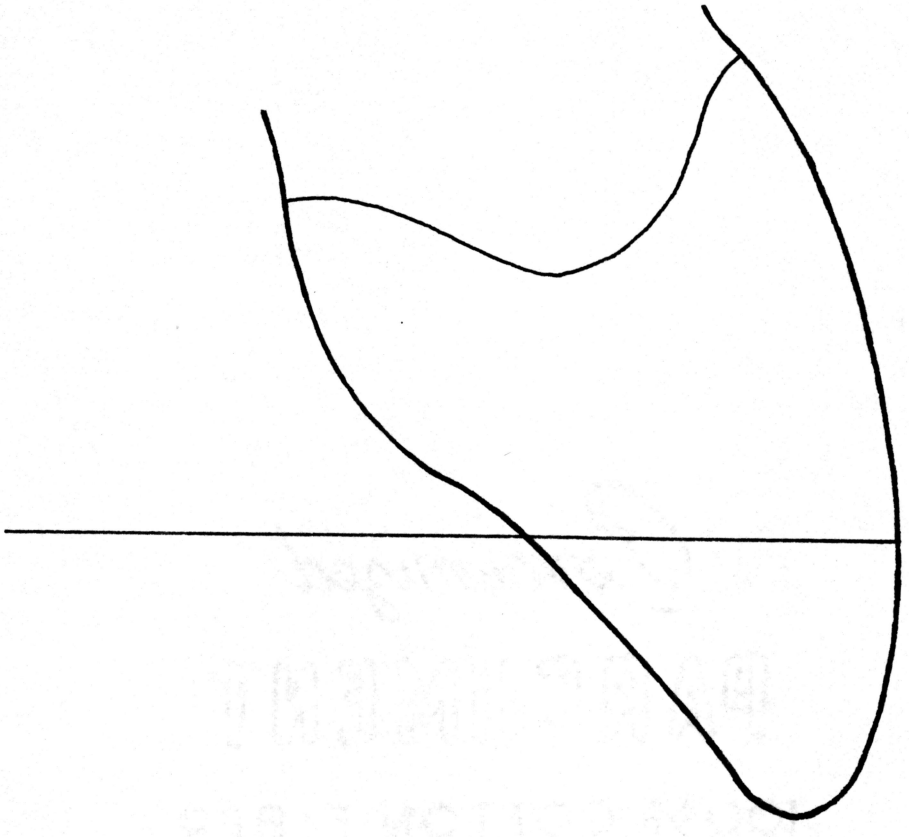


FIGURE 4 - Construction of LA point and measurement of torque

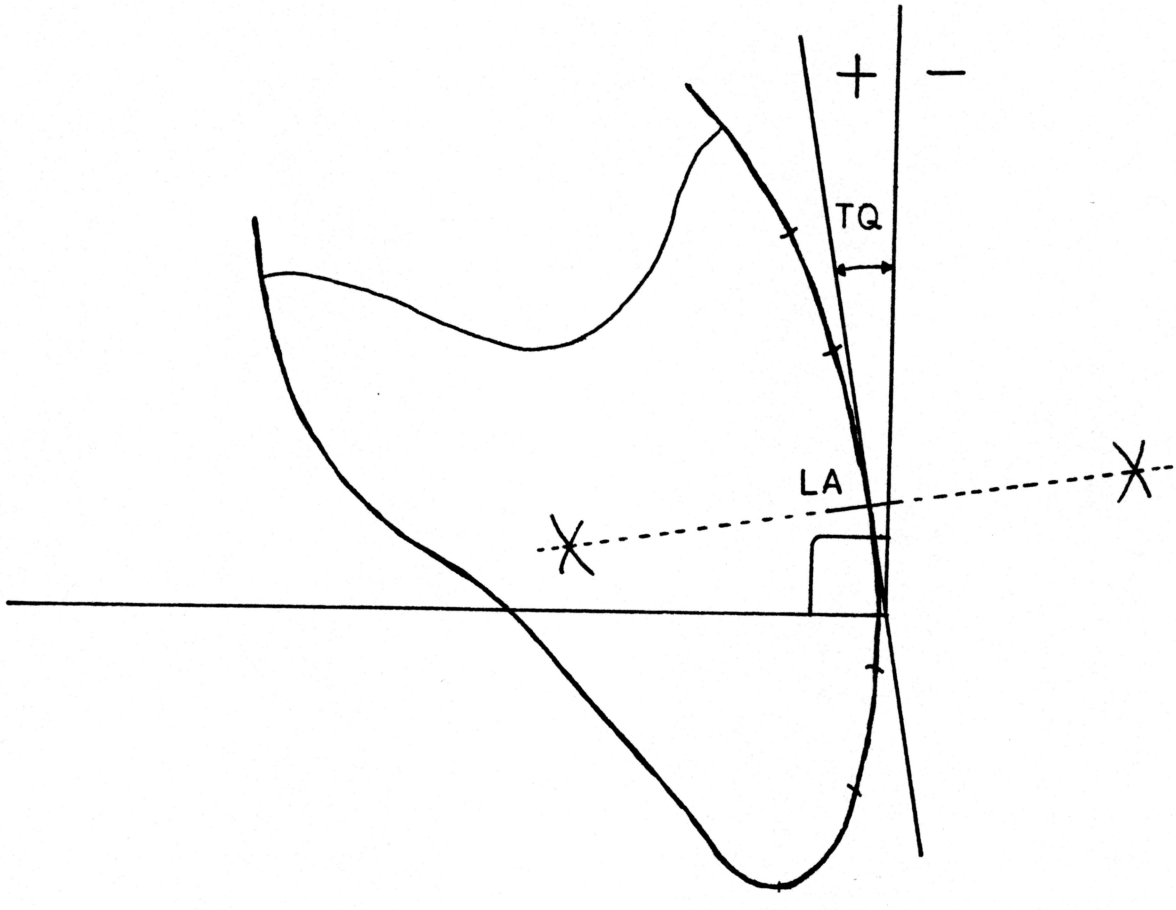
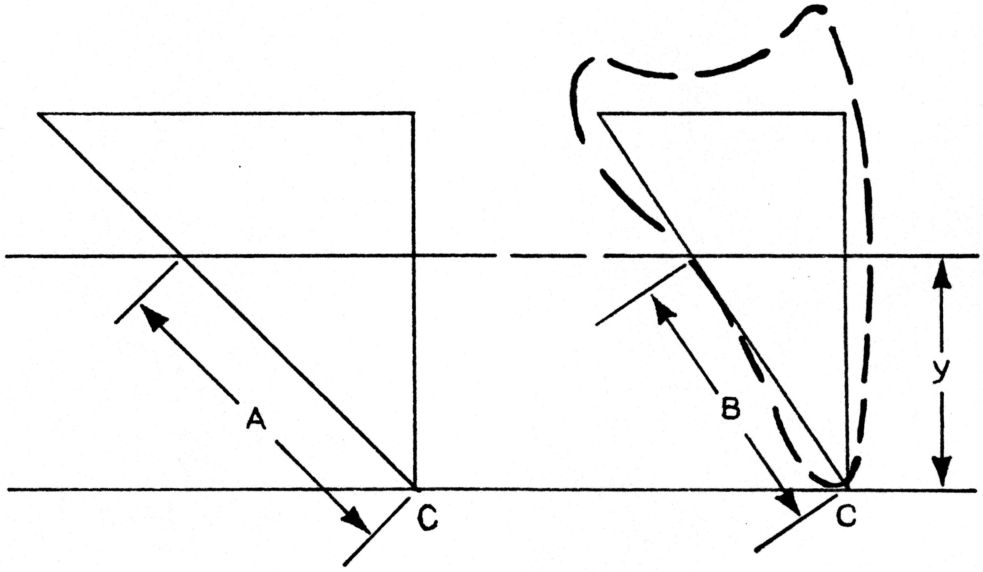


FIGURE 5 - Bracket Height



Bracketts placed at the same height (y) on different lingual slope angulations will be located at various distances from the incisal edge (C). A is greater than B.

TABLE I

TORQUE MEASUREMENTS

TOOTH NUMBER	LAB		EXPERIENCED PRACTIONERS	
	1	2	3	4
4	-06,-12,-17,-04	00,-04,-06,+02	-09,-09,-20,+02	+05,-04,-19,+05
5	-17,-12,-17,-05	-08,+02,-10,-06	-11,-11,-16,-01	-05,+02,-14,-02
6	+08,+01,-17, 00	-08,-06,-15, 00	-01,-07,-12,+03	-06,-09,-16,+06
7	+11,+10,+06,+02	+06,+09,+08,+03	+06,+12,+07,+15	+08,+11,+18,+10
8	+26,+14,+19,+11	+16,+18,+15,+12	+30,+21,+16,+25	+27,+12,+18,+16
9	+06,+11,+22,+13	+08,+16,+21,+07	+13,+21,+18,+20	+15,+13,+17,+14
10	+10,+08,+15,+16	-02,+06,+12,+10	+01,+09,+07,+05	+05,+14,+13,+15
11	+11,-01,-10,-06	-04,-04,-04,+04	-05,-03,-04,+02	-06,-06,+01,+06
12	-07,-08,-10,-06	-06,+02,-07,-05	-10,-08,-12, 00	+03, 00,-07,+01
13	-08,-09,-13,-05	-07,-07,-12,-02	-15,-06,-12,-02,	-08,-09,-04,-01
20	-16,-17,-34,-13	-16,-20,-34,-09	-15,-27,-22,-10	-15,-15,-24,-11
21	-10,-08,-19,-10	-18,-19,-25,-16	-16,-20,-20,-07	-20,-22,-26,-22
22	-06,-08,-14,-01	-15,-13,-08,-01	-05,-05,-13,+04	-08,-08,-11,+02
23	+01,-07,-01,-05	-03,-02,+06,+06	-07,-02,-06,+05	-01,-02, 00,+07
24	+02,-03,+03,+05	+02,+10,+05, 00	+04,+08,-02,+10	00,+04,+05,+08
25	+06, 00,+11,+06	+04,+05,+13,+05	+04,+10,+03,+07	-01,+04,+06,+06
26	-02,-06,+07,+05	00,+02,+11,+08	-04,-02, 00,+15	-01,+02,+05,+10
27	-08,-12,-06,+04	-13,-12,-01,+06	-12,-10,-07,+07	-10,-10,-08,+04
28	-10,-15,-25,-24	-15,-16,-22,-20	-21,-21,-21,-23	-21,-22,-15,-29
29	-17,-23,-31,-12	-10,-24,-27,-07	-19,-28,-28,-09	-15,-30,-32,-11

* The numbers in the columns represent cases 1-4, respectively.

TABLE II

TORQUE MEASUREMENTS

INEXPERIENCED PRACTIONERS

TOOTH NUMBER	5	6	7	8
4	-05,+01,-17,-17	-11,-08,-19,-03	-03,-06,-09,-01	-05,-10,-33, 00
5	-11,+02,-17,-03	-17,-11,-13,-07	-02,-05,-12,-07	-25,-06,-29,-06
6	-08,-04,-15,+04	-05,-09,-13,+03	-07,-05,-10,+04	-08,-09,-10,+09
7	+04,+06,+02,+07	+05,+09,+04,+03	+07,+07,+07,+03	+05,+10,+13,+11
8	+17,+17,+13,+14	+30,+16,+16,+16	+24,+13,+25,+20	+11,+18,+20,+18
9	+10,+15,+12,+08	+17,+19,+17,+10	+14,+13,+22,+13	+07,+17,+15,+13
10	+02,+04,+01,+09	+05,+11,+09,+07	00,+15,+10,+05	+02,+10,+03,+19
11	-05,-05,-08,+04	-04,-09,-05,+03	-02,+04,-06,+05	-05,-03,-04, 00
12	-17,-11,-22,-17	-11,-03,-12,+01	+04,+01,-07,+02	-05,-07,-07,-08
13	-26,-17,-20,+04	-21,-14,-16,+03	-07,-03,-05,-01	-16,-22,-18,+06
20	-12,-16,-06,+05	-20,-17,-21,-13	-15,-15,-24,-19	-01,-05,-27,-02
21	-05,-04,-31, 00	-07,-17,-27,-16	-17,-16,-25,-09	-12,-01,-19,-11
22	-14,-16,-11,+05	-12,-14,-05, 00	-19,-01,-14,+03	-03,-08,-07,+02
23	-01,-04,-04,+06	-06,-04,-02,+07	-10,-05,-01,+02	-04,-13,-01,+08
24	-02,+02,+02,+03	-02,+06,+05,+05	-01,+01,+03,+05	00,-04,+04,+09
25	+01,+05,+05,+06	-02,+01,+11,+06	-01,+03,+07,+06	00,+02,+07,+13
26	-05,-02,+08,+03	+05,+02,+05,+05	-01,-03,-02,+04	-04,+05,+03,+11
27	-10,-08,-06,+01	-12,-11,-07,+10	-11,-07,-07,+04	-11,-03,-09,+07
28	-08,-20,-11,-04	-27,-19,-25,-08	-17,-20,-22,-27	-20,-05,-15,-24
29	-21,-21,-25,-02	-15,-21,-26,-25	-17,-27,-27,-09	-10,-20,-17,-09

*The numbers in the columns represent cases 1-4, respectively.

TABLE III

IDEAL TORQUE

TOOTH NUMBER	
4	-07
5	-07
6	-02
7	+08
8	+12
9	+12
10	+08
11	-02
12	-07
13	-07
20	-22
21	-17
22	-11
23	+01
24	+01
25	+01
26	+01
27	-11
28	-17
29	-22

TABLE IV

MEAN AND STANDARD DEVIATION FOR ABSOLUTE DIFFERENCE IN TORQUE

*	1	2	3	4	5	6	7	8
Mean	5.11	4.49	5.45	5.35	6.47	5.15	4.69	6.66
Standard Deviation	3.77	3.90	4.02	3.82	5.32	3.93	3.71	5.84
**	3	1	6	5	7	4	2	8

* 1-laboratory, 2-4 experienced practitioners, 5-8 inexperienced practitioners

** Ranking from lowest mean absolute torque difference

n=80 for practitioner and laboratory

TABLE V

PAIRED T-TEST FOR EXPERIENCED AND INEXPERIENCED PRACTITIONERS

COMPARED TO THE LABORATORY

* ABSOLUTE DIFFERENCE	N	MEAN DIFFERENCE	STANDARD DEVIATION OF DIFFERENCE	PAIRED T	P
2	80	-0.52	4.16	-1.13	0.26
3	80	0.34	4.68	0.65	0.52
4	80	0.24	4.26	0.52	0.62
5	80	1.36	5.51	2.21	0.030
6	80	0.04	4.31	0.08	0.94
7	80	-0.42	4.62	-0.82	0.41
8	80	1.55	5.60	2.48	0.015

* Absolute difference in torque between each practitioner and the laboratory