ORTHODONTIC BAND RETENTION ON PRIMARY MOLAR STAINLESS STEEL CROWNS: AN IN VITRO ANALYSIS

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ABSTRACT

One-hundred and twenty trimmed and crimped Unitek maxillary and mandibular 1st and 2nd primary molar stainless steel crowns were fitted with one of four commonly used orthodontic bands (Unitek regular, Unitek narrow, Rocky Mountain, and custom bands) and cemented with glass ionomer cement. The cemented samples were tested for their resistance to dislodgement on the Instron Universal Testing Machine in tensile mode. Unitek regular bands tested either statistically equivalent or superior to the other bands on the 2nd primary molar samples. Unitek narrow bands tested either statistically equivalent or superior to custom bands on the 1st primary molar samples.

The inside band and the outside band bearing surfaces of selected crowns were then lightly scored with a diamond bur, recemented, and retested on the Instron. All roughened test samples exhibited significantly superior retention compared to the values obtained in their pre-roughened state. Retention improved from 107% to 340%. The values obtained using the roughened band/crown interface technique compared favorably with retention values for orthodontic bands cemented on permanent molar and pre-molar teeth, from the literature. Placing a band and loop space maintainer on a deciduous molar stainless steel crown using the roughened band/crown interface technique will greatly increase the retention of the appliance.

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Orthodontic Band Retention on Primary Molar Stainless Steel Crowns: An in vitro analysis

INTRODUCTION:

The rationale for, use, and design of the fixed unilateral space maintainer is well established in the practice of pediatric dentistry when a deciduous molar is prematurely lost. A space maintainer prevents the migration of adjacent teeth, thus holding space in the dental arch for the succedaneous tooth to erupt. Fixed unilateral space maintainers may be of two types according to the current clinical guidelines of the American Academy of Pediatric Dentistry. They are the band and loop, and the crown and loop.[1]

When the adjacent deciduous molar to be used as an abutment for the appliance is in sound condition, the band and loop type fixed space maintainer is the accepted treatment. Carious attack is usually the culprit in the premature loss of a deciduous molar and often the adjacent primary molar requires definitive restoration with a stainless steel crown. When this clinical situation arises, the practitioner must treatment plan whether to place a crown and loop appliance or a band and loop appliance cemented on a deciduous molar stainless steel crown. It is in this decision that debate seems to exist, on a anecdotal level, over the efficacy of one technique over the other.

The crown and loop intuitively has the advantage of superior retention, but is difficult to adjust intraorally if deformed or rotated. If broken or if replacement is required, the crown must be cut off and a new crown and loop appliance fabricated. A common technique for the fabrication of the crown and loop space maintainer utilizes two appointments and requires that an interim crown be placed. Local anesthetic is generally deemed necessary at each appointment. Placing a band and loop on a deciduous molar stainless steel crown is a simpler and less time consuming procedure clinically. Only one crown need be placed at the initial appointment and the administration of local anesthetic is usually not required for the second cementation appointment. If the need arises, the band and loop can be removed, adjustments made or a new appliance fabricated, and recemented without necessitating the removal of the abutment stainless steel crown. It is for these reasons that Christensen and Fields, in their chapter on space maintenance in Pinkham's textbook on pediatric dentistry, advise that the crown and loop is not a recommended technique.[2] For the immature uncooperative child who needs sedation or general anesthesia in order to accomplish dental treatment, the band and loop appliance cemented on a stainless steel crown abutment would seem to be the preferred procedure. The appliance can be cemented at the post operative appointment, following operating room treatment, with much less effort than compared with the alternative crown and loop.

Intuitively, one might question whether the conical shape of deciduous molar crowns, especially first molars, would provide a sufficient retentive structure for an orthodontic band. McDonald, Hennon, and Avery in their current textbook on dentistry for children address this question by stating that a primary first molar stainless steel crown provides a desirable retentive contour for the placement of a stainless steel band.[3] This statement is made in the context of a technique for the fabrication of the distal shoe appliance where the second deciduous molar has been lost prior to the eruption of the first permanent molar.

The retention of stainless steel orthodontic bands cemented on deciduous molar stainless steel crowns has not been investigated in the pediatric dental literature. The retention of stainless steel bands cemented to permanent molar and premolar teeth has been quantified by in vitro analyses.[4,5] If the forces required to dislodge an orthodontic band cemented on a deciduous molar stainless steel crown were similar to those needed to dislodge a band cemented on a permanent posterior tooth, than a clinician would be justified in selecting the band and loop type appliance cemented on a primary molar crown abutment for preserving arch space in pediatric dental patients who exhibit premature loss of a deciduous molar.

The purpose of this laboratory study was to quantify and compare the retention of four different types of orthodontic bands commonly used in the fabrication of fixed unilateral space maintainers. These bands were cemented on Unitek (3M Co.) maxillary and mandibular 1st and 2nd deciduous molar stainless steel crowns with glass ionomer cement. Unitek crowns have been shown to have superior retention to Ion (3M Co.) pre-contoured crowns and are commonly used by pediatric dentists.[6] Glass ionomer cement was chosen because it has been shown to be less soluble in the oral environment than zinc phosphate cement and possesses some chemical bond to stainless steel.[7,8] Zinc phosphate cement relies on a purely mechanical bond.

This investigation attempted to determine if there were significant differences in the retentive abilities of the different band types selected for study. Secondly, the influence of roughening the band/stainless steel crown interface was analyzed to determine if cement bond strength was improved, and if so by how much. Lastly, a chart was formulated matching Unitek primary 1st and 2nd molar stainless steel crowns of the various sizes with corresponding orthodontic bands in order to facilitate the selection of the appropriate band in the clinical setting.

MATERIALS AND METHODS:

To evaluate the retention of stainless steel orthodontic bands cemented with glass ionomer to deciduous molar stainless steel crowns, this investigation utilized Unitek right primary 1st and 2nd molar size #4 crowns. To simulate clinical crown restorations, the stainless steel crowns used in this study were trimmed and crimped as follows:

No. of Samples	Unitek Crown	Amount Trimmed
40	UR 2nd #4	.7 mm off mid-lingual
		.5 mm off mid-buccal
40	LR 2nd #4	.5 mm off mid-lingual
		.5 mm off mid-buccal
20	UR 1st #4	0 mm off mid-lingual
		.5 mm off mid-buccal
20	LR 1st #4	.25 mm off mid-lingual
		.5 mm off mid-buccal

The reductions indicated as trimmed off the mid-points of the buccal and lingual surfaces were feathered into the proximal line angles. No reduction was made off the mid-proximals. Trimming was accomplished using curved crown and bridge scissors and a SHOFU Chipless Dura-Green Wheel on a straight slow speed handpiece. Crown margins were polished with a brown Burlew Whiz Wheel (Jelenko).

Crimping was performed with a Rocky Mountain Co. #114 contouring plier. All samples of like crowns (UR 2nds, LR 2nds, UR 1sts, and LR 1sts) were made as similar as possible and "typical" of crown restorations to be placed clinically.

To verify the similarity of trimmed and crimped crowns within like crown groups, samples were first weighed on a Mettler PJ 360 Delta Range Electronic Scale in the trimmed and untrimmed state. Measurements were then made, using a boley gauge, of the greatest transverse inside diameter dimension from mesial-buccal to distal-lingual, and from mesial-lingual to distal-buccal of the crimped crowns.

Once the crowns were trimmed, crimped, and polished, a skirt of 3/4" masking tape was placed around the periphery of each crown. A 1 1/2" 8/32 truss head machine screw, with the head sized down to fit, was placed into each crown and self-polymerizing dental acrylic (Neopar) was then salt and peppered past the stainless steel crown margins up into the masking tape skirt. This formed a solid acrylic lug, mimicking a prepared tooth, which anchored the crown onto the machine screw (Figure 1 of Appendix 3). The machine screw was placed perpendicular to the occlusal plane, or in other words, in the occlusal-gingival long axis of each sample. A custom jig was designed for this purpose, but deviations from perpendicular to the occlusal plane still occurred and were measured and recorded.

One-hundred and twenty test samples were made. This investigation looked at the retention of different orthodontic bands cemented on different Unitek deciduous molar stainless steel crowns. The factory bands selected exhibited the best clinical fit on their respective crown samples. The bands tested on specific samples are indicated below.

Group	No. of Samples	Unitek Crown	Band
	10	UR 2nd #4	Unitek U33
I	10	UR 2nd #4	Unitek NU33 1/2
	10	UR 2nd #4	Rocky Mountain U6.5
	10	UR 2nd #4	Custom
	10	LR 2nd #4	Unitek L33 1/2
II	10	LR 2nd #4	Unitek NL33 1/2
	10	LR 2nd #4	Rocky Mountain L4.5
	10	LR 2nd #4	Custom
III	10	UR 1st #4	Unitek NL26
	10	UR 1st #4	Custom
IV	10	LR 1st #4	Unitek NL25
	10	LR 1st #4	Custom

Each band was fitted to and matched with its own crown sample. This mating was maintained throughout the investigation. An anomaly occured within Group I. Whereas Unitek U33 bands fit well and seated appropriatly, Unitek NU33 bands fit slightly tight and would not seat completely. Therefore, Unitek NU33 1/2 bands were selected which gave a clinically acceptable fit.

Custom bands were fabricated by taking the next size larger Unitek primary molar stainless steel crown and trimming and polishing the gingivals the same as the crown it was to be seated on. Next, the crown's occlusal surface was removed using a Leco wet belt grinder. A standard dental laboratory model trimmer or a carbide bur in a high speed handpiece could also be used for this purpose. The rough occlusal margins were polished with a green stone and brown Berlew wheel, thus forming a custom band. Measurements were made of the mid-buccal, lingual, mesial, and distal widths of the custom and factory bands using a boley gauge. Custom and factory bands were then fitted on their respective crowns and burnished to a clinically acceptable fit. The bands were not crimped, and the gingival margins did not extend beyond the host crown's gingival margins.

Buccal and lingual lugs were then fabricated from .045 stainless orthodontic wire cut into lengths approximately 10 mm long. The distal 2 mm or so of each wire's ends were bent down, using a three prong plier, at an angle of approximately 30 degrees. The bends were in the same plane. The lugs were spot welded (using a Unitek Model #1071 spot welder) and soldered onto the mid-buccal and lingual surfaces of the bands parallel to their occlusal planes (Figures 1-3 of Appendix 3). After flame soldering the lugs in place, the bands were cleaned in an acid bath electro-polisher (Rocky Mountain Orthodontics Model #710) for 30 seconds to remove flux and oxide coatings.

The bands with lugs attached were cemented on the stainless steel crown samples using Ketac-Cem (ESPE Co.) glass ionomer cement. A powder to liquid ratio of one level scoop to three drops yielded a more workable consistency for band cementation than the manufacturer's recommended powder to liquid ratio of one level scoop to two drops, which was deemed to be too thick for this application. Once cemented, the samples were stored at room temperature in a humidor for a minimum of 24 hours before testing.

The samples with the cemented bands were then pulled using the Instron Universal Testing Machine (Model #TTCL) in tensile mode (Figures 4-6 of Appendix 3). In order to easily affix the samples to the Instron, a female couple adaptor was fabricated from 3/8" diameter steel rod approximately 3" in length. One end of the rod was drilled and tapped to accept the machine screws used to make up the samples. Near the opposite end of the rod, a 1/4" diameter hole was bored through the rod, perpendicular to its long axis. This threaded couple adaptor was attached via a pinion, through the 1/4" diameter hole, to the universal joint which was connected to the Instron's load cell. This threaded couple adaptor allowed samples to be quickly and easily attached to the Instron and removed after testing. To engage the lugs soldered to the buccal and lingual surfaces of the bands, a 6 1/2" adjustable machinists outside diameter caliper was adapted for this purpose. This caliper was easily adjusted to engage the lugs on an individual band by using the thumb screw. The modified caliper was affixed via a pinion couple to the cross head of the Instron. The Instron was run at a cross head speed of 0.1" per minute. The load range set for the recording chart was 0-50 pounds. Chart speed was set at 0.5" per minute. Each sample was pulled on the Instron until the band was visibly dislodged in an occlusal direction on the crown. The maximum force recorded on the load-displacement graph was noted. During the process of pulling some of the samples, the crowns slowly slipped in an occlusal direction on their acrylic copings. When this was detected, the test cycle was stopped. If the cement bond of the band to the crown was intact, cyanoacrylate (Super-Glue) was spread around the crown's gingival margins and the crown fully reseated on its acrylic coping. Excess cyanoacrylate was wiped off. The sample was then retested on the Instron until the band was dislodged from the crown. This solved the crown slippage problem.

After all the samples were tested once, the following bands listed below with their matching crown samples were cleaned in detergent and water in an ultrasonic cleaner to remove adherent cement.

No. of Samples	Unitek Crown	Band
10	UR 2nd #4	Unitek U33
10	LR 2nd #4	Unitek L31 1/2
10	LR 2nd #4	Custom
10	UR 1st #4	Unitek NL26
10	LR 1st #4	Unitek NL25

Using a Brassler bullet nose diamond bur (#856-018) in a high speed dental handpiece, the inside of the above listed bands and the band bearing buccal, lingual, mesial, and distal surfaces of the 2nd molar crowns, and the buccal, lingual, and distal surfaces of the 1st molar crown samples were lightly scored or roughened up. The mesial surfaces of the 1st molars were not scored because clinically, when a band and loop space maintainer is needed on a 1st primary molar abutment, there is almost always a cuspid present blocking access to the mesial surface of the 1st molar. The bands were then recemented on their matching crowns and pulled on the Instron as previously described. The load range of the recording chart was increased to 0-100 pounds. Again, the maximum force recorded on the load-displacement graph required to visibly dislodge a cemented band from its crown was noted.

Due to the dissimilarity of the intrinsic shapes of the crowns in the four different sample groups, and the differences in the sizes of the bands which fit these crowns, statistical analysis between groups could not be performed. With respect to statistical analysis, this study is composed of four separate investigations based on the four primary molar crown groups (I-IV) of sample material previously described. The data obtained from the Instron testing was statistically analyzed within groups using ANOVA and Newman-Keuls multiple comparisons tests, and t-tests where appropriate. F-tests were used to determine homogeneity of variance. Where the assumption of homogeneity of variance for statistical testing was violated, multiple t-tests were used with corrected table values[9] where indicated to confirm ANOVA results. Alpha level for statistical significance was set at $\alpha=0.05$.

RESULTS:

Uniformity of the Sample Material

The uniformity of the sample material was analyzed in Appendix 1 (pp. 28-51). The trim and crimp of the stainless steel crowns was compared within groups. The amount of variation the samples exhibited from their respective mean values ranged from 0-5%. This small amount of variation suggests the likeness of the prepared stainless steel crowns within groups. The custom bands were measured and graphically compared with competing Unitek factory bands used in this study. The custom and factory bands were very similar in their occlusal-gingival dimensions. In many instances, the custom bands were wider than the Unitek bands. The amount of angulation exhibited by the machine screws away from the long axes of the sample crowns ranged from 0-5 degrees. This amount of variation should have been neutralized by the Instron's universal joint. Therefore, the samples exhibited a degree of precision in their fabrication which allows for the following statistical analyses of band retention.

Group I Analysis

Group I samples consisted of 40 Unitek #4 UR 2nd deciduous molar crowns.

Band Retention- Four commonly used orthodontic band types were tested for differences in retention on similarly trimmed and crimped stainless steel crowns. There were 10 samples in each of the four band type subgroups. Figure #1 shows the mean retention ± 1 SD in lbs. for each band type. Statistical analysis of the data using ANOVA and Newman-Keuls multiple comparisons test indicated that the custom band subgroup (X=12.3 ± 4.1 lbs) had significantly less retention than the Unitek U33 (X=28.3 ± 7.4 lbs), Unitek NU33 1/2 (X=25.1 ± 9.9 lbs), or the Rocky Mountain U6.5 (X=22.4 ± 4.1 lbs) subgroups, the latter three being statistically equivalent (Table 1 of Appendix 2).

Group II Analysis

Group II samples consisted of 40 Unitek #4 LR 2nd deciduous molar crowns.

Band Retention- There were 10 samples in each of the four band type subgroups studied. Figure #2 shows the mean retention ± 1 SD in lbs. for each band type. Statistical analysis of the data using ANOVA and Newman-Keuls multiple comparisons test indicated that the Unitek NL31 1/2 (X=6.4 ± 1.7 lbs.) exhibited significantly less retention than the custom band (X=16.8 ± 4.9 lbs.), Rocky Mountain L4.5 (X=16.8 ± 6.9 lbs.), or the Unitek L31 1/2 (X=15.3 ± 6.2 lbs.) subgroups, the latter three being statistically equivalent (Table 2 of Appendix 2).

Group III Analysis

Group III samples consisted of 20 Unitek #4 UR 1st deciduous molar crowns.

Band Retention- There were 10 samples in each of the two band type subgroups studied. Figure #3 shows the mean retention ± 1 SD in lbs. for each band type. Statistical analysis of the data using a t-test indicated that the Unitek NL26 (X=17.1 ± 4.2 lbs) and the custom band (X=17.8 ± 2.4 lbs) subgroups were statistically equivalent (Table 3 of Appendix 2).

Group IV Analysis

Group IV samples consisted of 20 Unitek #4 LR 1st deciduous molar crowns.

Band Retention- There were 10 samples in each of the two band type subgroups studied. Figure #4 shows the mean retention ± 1 SD in lbs. for each band type. Statistical analysis of the data using a t-test indicated that the Unitek NL25 subgroup (X=20.4 ± 3.4 lbs) exhibited significantly more retention than the custom band subgroup (X=12.9 ± 4.2 lbs) as indicated in Table 4 of Appendix 2.

Roughened Groups

Figure #5 shows the mean retention ± 1 SD in lbs. for each group before and after roughening the band/crown interface. Statistical analysis of the data using a t-test on repeated measures indicated that all bands had significantly more retention after roughening. The four crown groups with their corresponding bands, UR 2nd-U33, LR 2nd-L31 1/2, UR 1st-NL26, and LR 1st-NL25 had respectively 107%, 300%, 331%, and 160% more retention after roughening (Tables 5A&B of Appendix 2).

When the roughened LR 2nd-custom group was tested against the LR 2nd-L31 1/2 group via the t-test, no statistical difference was found (Figure 6 and Table 5 of Appendix 2).

FIGURE 1

Unitek UR 2nd Primary Molar SSC's

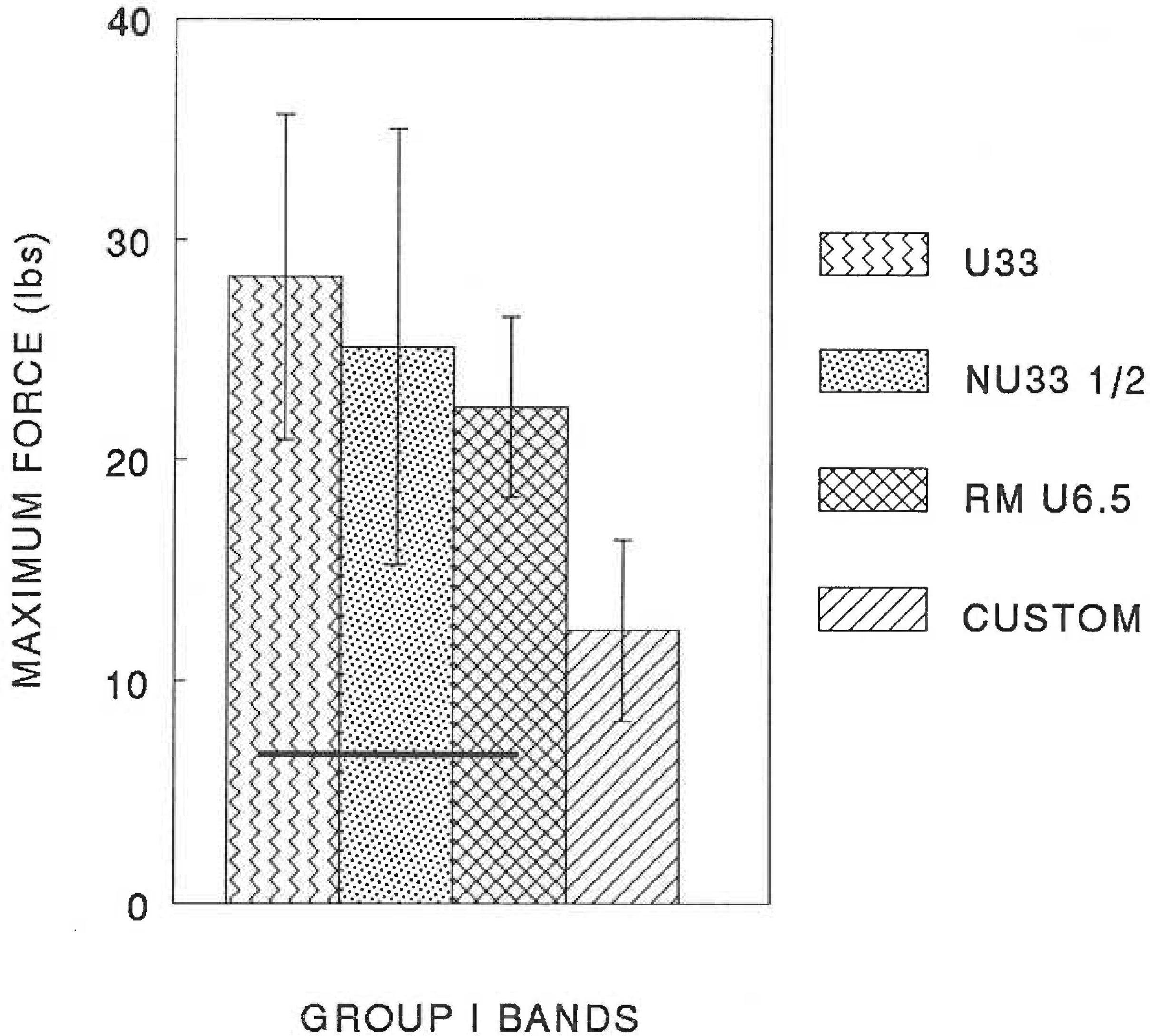


FIGURE 2

Unitek LR 2nd Primary Molar SSC's

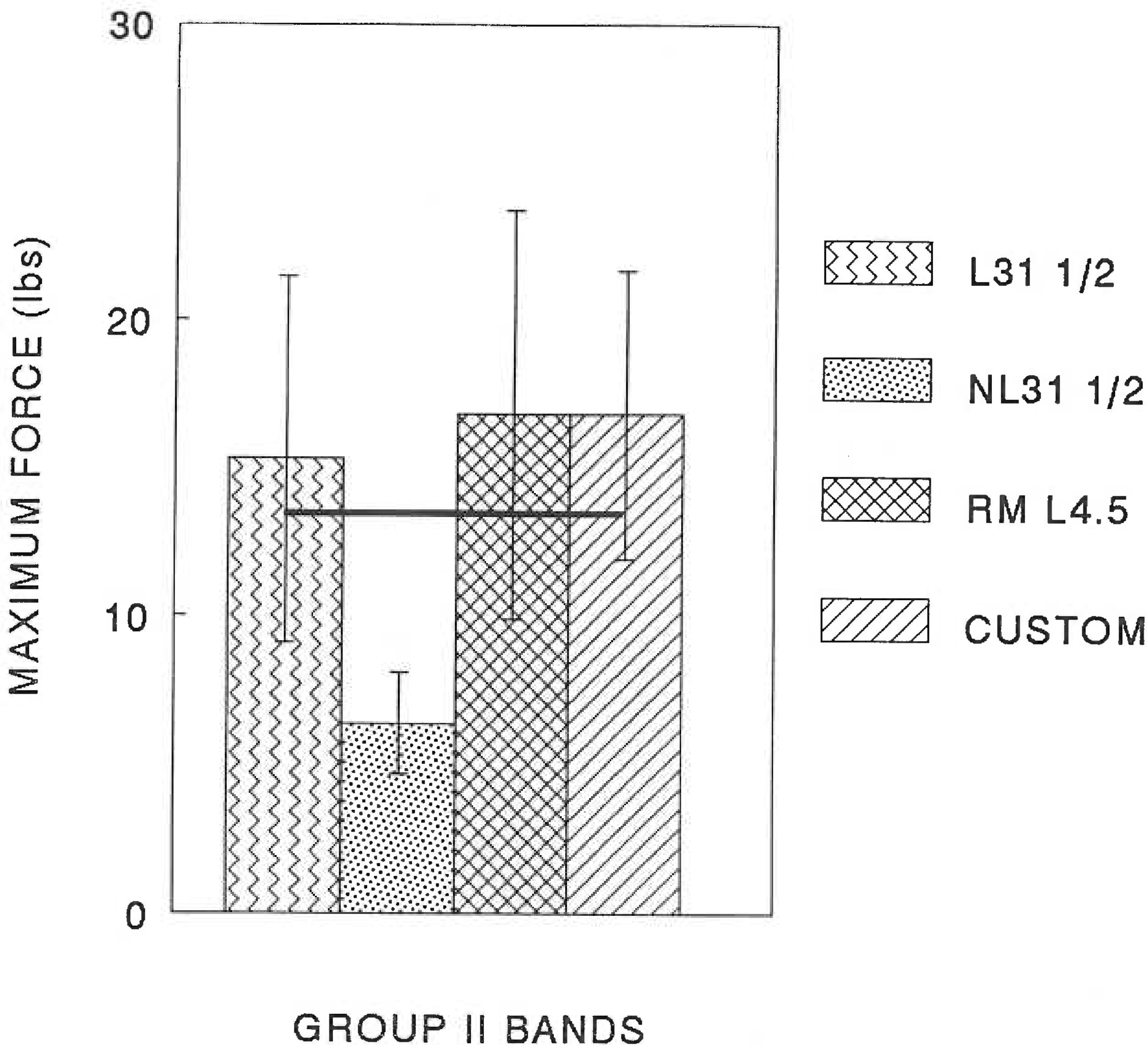


FIGURE 3

Unitek UR 1st Primary Molar SSC's

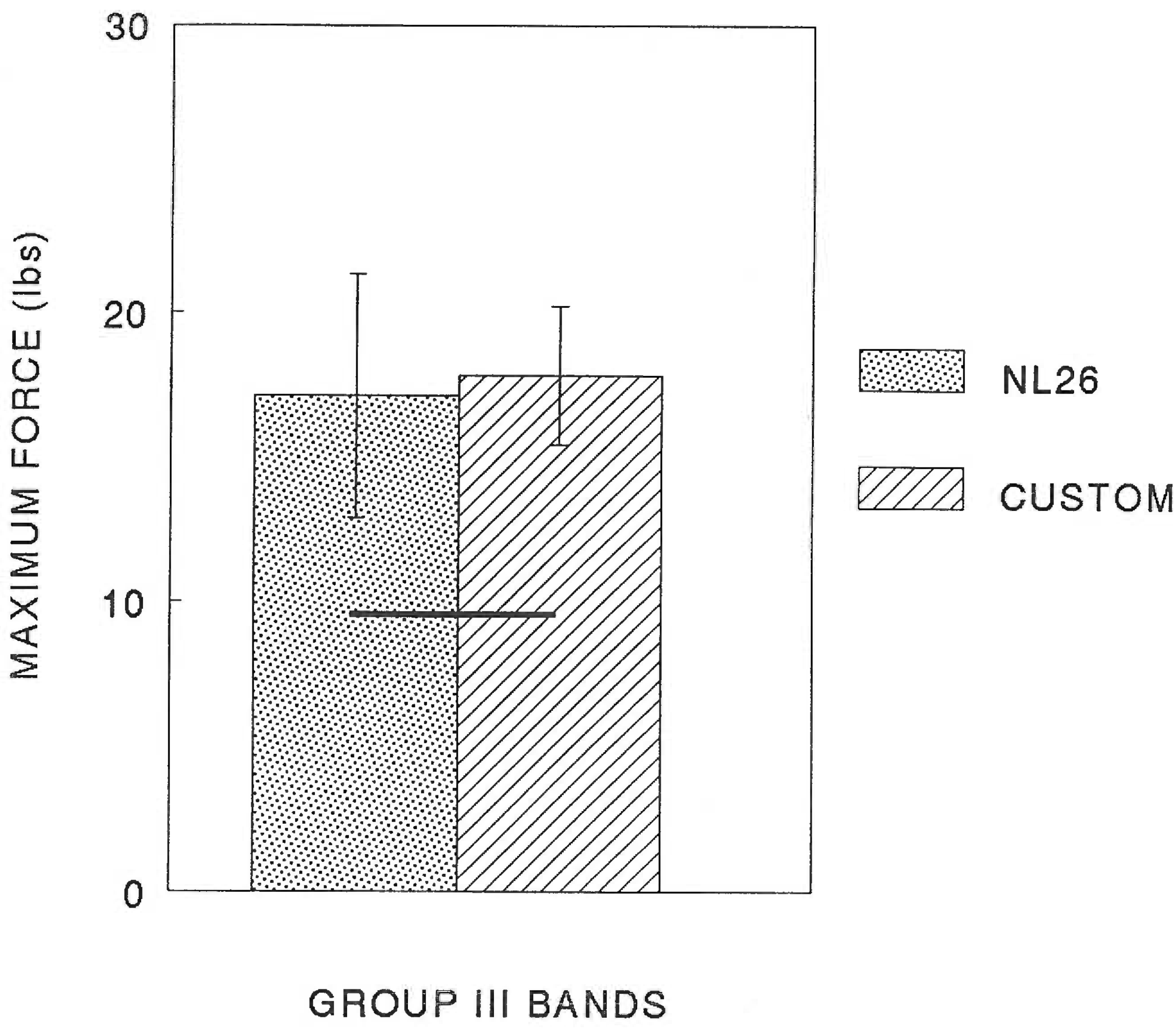


FIGURE 4

Unitek LR 1st Primary Molar SSC's

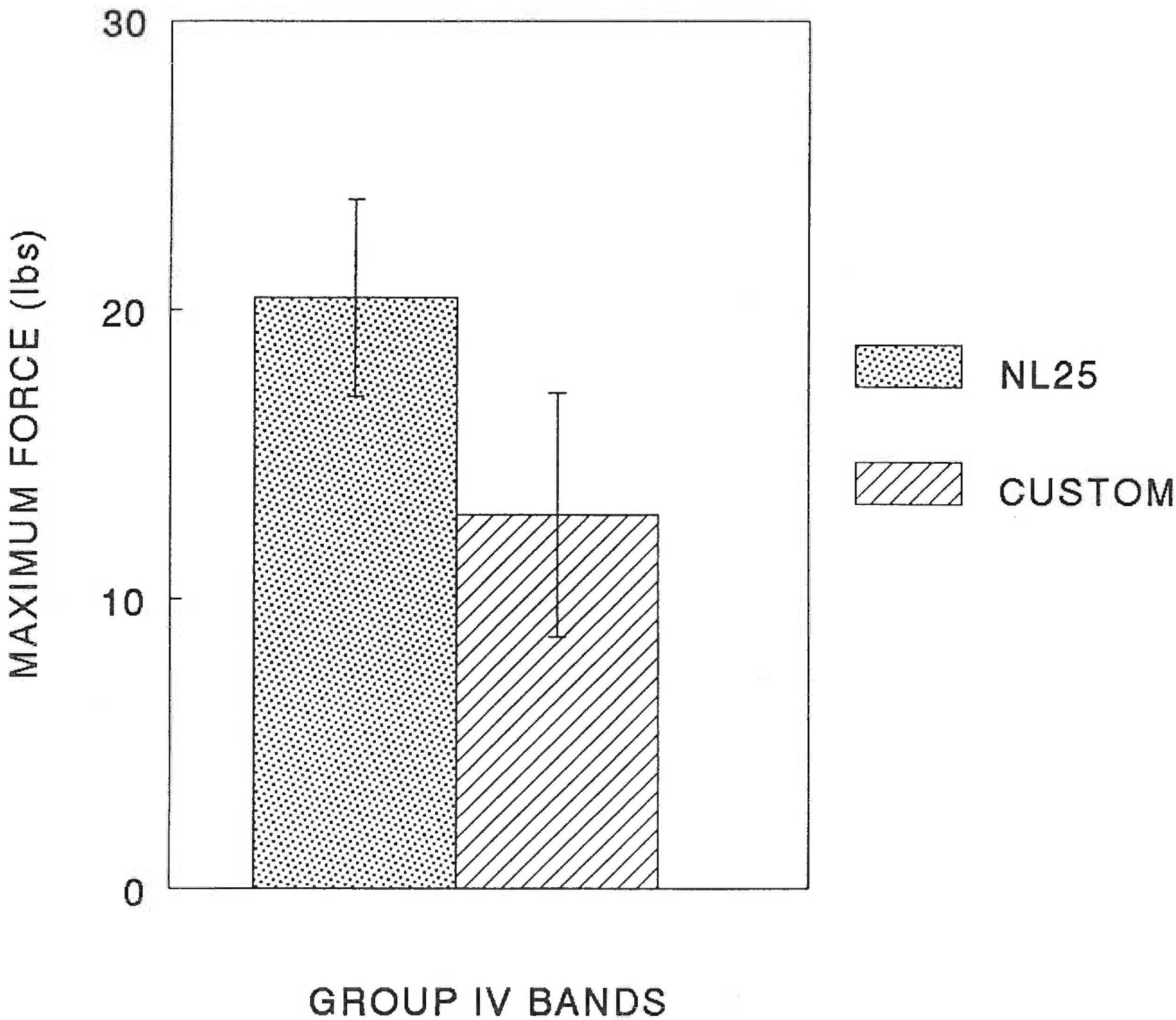


FIGURE 5

Roughened Band-Crown Interface

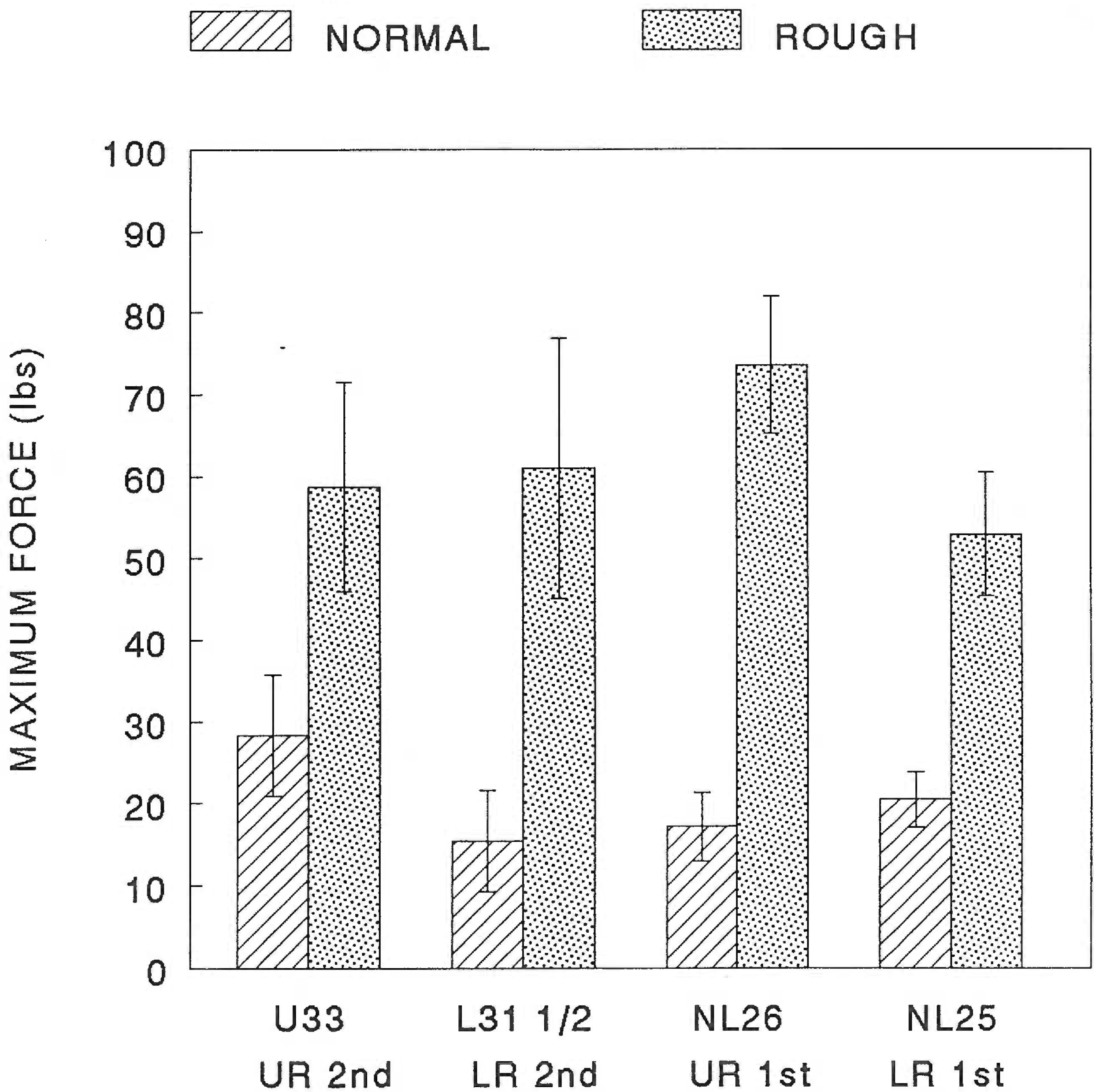
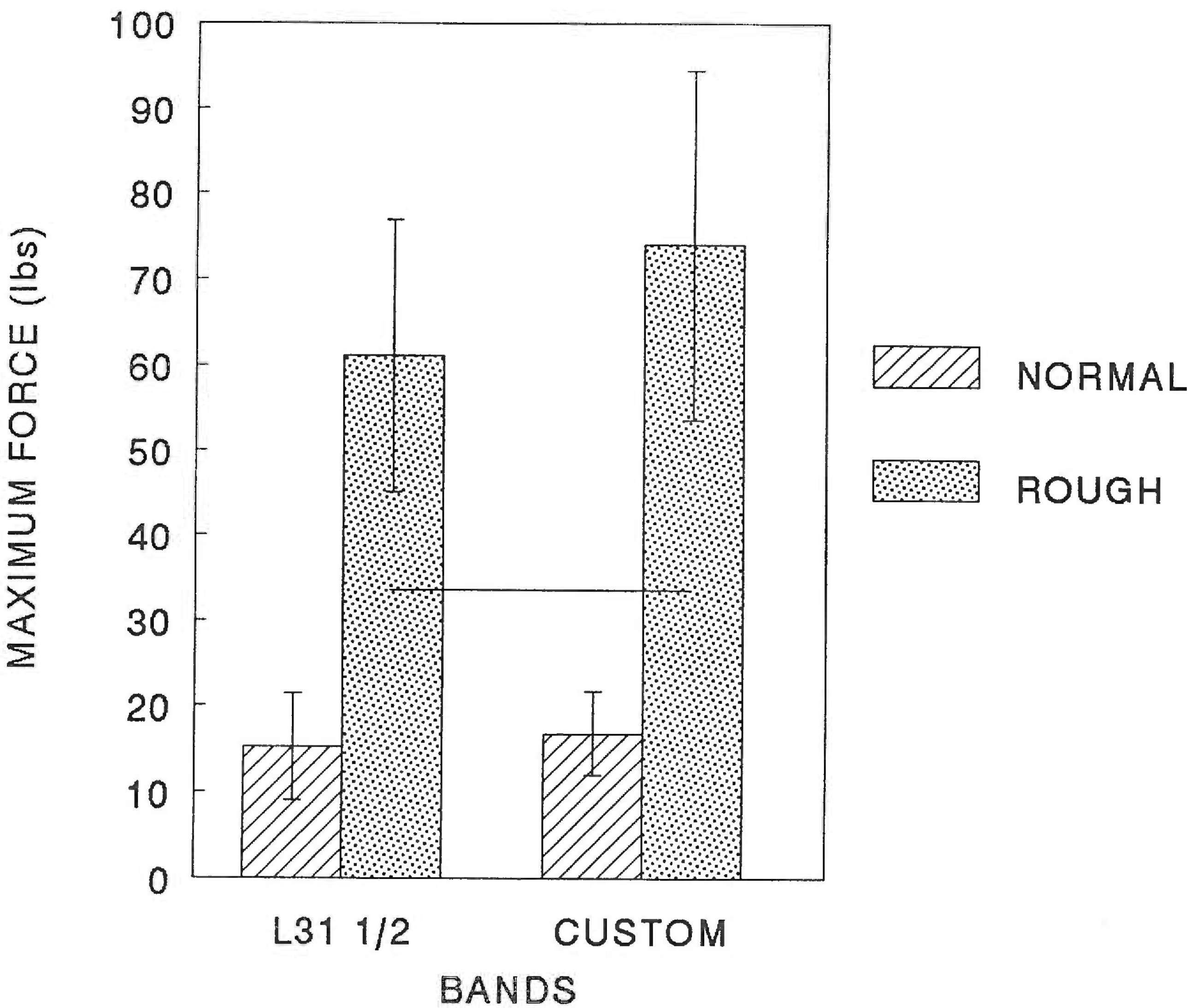


FIGURE 6

Unitek LR 2nd Primary Molar SSC's



DISCUSSION:

When rendering dental treatment to the immature child patient in the office setting, or when dental treatment is performed in the operating room under general anesthesia, time is a very valuable commodity. The fabrication of a custom orthodontic band to be used in the making of a band and loop space maintainer indeed takes more time than selecting a factory band. This investigation set out to determine if custom bands fabricated from the next size larger Unitek deciduous molar stainless steel crown had any advantage in retention when compared to three types of factory bands. Differences in the inherent retention of the three types of factory bands was also evaluated. Upon statistical analysis of the data from within Groups I,II,III, and IV, the custom bands tested exhibited no statistical advantage in retention, being either statistically equivalent or inferior, compared with Unitek regular bands when cemented on the maxillary and mandibular 2nd primary molar crowns (Groups I and II). Also, custom bands had no statistical advantage over the Unitek narrow bands when tested on maxillary and mandibular 1st deciduous molars (Groups III and IV). Unitek regular and Rocky Mountain bands did not fit the deciduous 1st molar crowns well, being too tall when seated. Therefore, they were not tested on these samples in this investigation.

Upon manipulation, the Rocky Mountain bands gave the impression that they were stiffer than Unitek bands and therefore may offer better retention when fitted and cemented because they are more difficult to deform. However, Rocky Mountain bands tested on the maxillary and mandibular deciduous 2nd molar crowns offered no statistical advantage in retention over Unitek regular bands.

The reason(s) that certain band subgroups exhibited significantly less retention than their competitors is interesting to contemplate. For instance, the Unitek narrow bands performed well on the upper 2nd molar crowns, but gave disappointing results on the lower 2nd molar samples. Custom bands performed equivalent to the Unitek narrow bands on the upper 1st molar samples, but exhibited significantly less retention on the lower 1st molar crowns. Variation in band retention could be explained by differences in band surface area, malleability of band material, band fit, retentive shape of host crown, and cement properties. Although there is no obvious explanation, a combination of crown shape and band fit is the most likely cause for the non-systematic differences in the results.

Visual examination of the bands dislodged from their respective crown mates prior to roughening revealed that the glass ionomer cement bond failure occurred almost uniformly between the cement and the stainless steel crown. This adhesive failure is most likely explained by the differences in the surface textures of the internal band and the external crown. The internal band surface, having gone through spot welding, heating during soldering, and acid bath electro-polishing, appeared to be irregular and exhibited areas with a dull etched appearance. In contrast, the surface of the Unitek stainless steel crown had a highly polished factory finish.

The major component of retention for glass ionomer, or any dental cement, is mechanical. It has been reported in the literature that the chemical adhesion of glass ionomer to stainless steel is equivalent to approximately 7% of the tensile strength of the cement (.7 MPa[8] vs. 8-12 MPa[10]), and to approximately 13% of the bond obtained between glass ionomer and tooth enamel (.7MPa vs. 5.35 MPa).[8] Therefore, the component of retention gained by the chemical bond of glass ionomer to stainless steel is minimal in comparison to mechanical adhesion. The highly polished surface of the stainless steel crown contributes little to mechanical retention.

The typical dislodged band retained a film of cement around its internal surface while the crown surface was clean with little or no retained cement. The band and cement basically pulled off the crown. Clinical studies of actual orthodontic cases by Maijer and Smith[10], Mizrahi[11], and Fricher,[12] and a laboratory study by Norris and associates,[5] concur that glass ionomer cement used to cement orthodontic bands had significantly better retentive strength to enamel than to band material. Thus, when bond failures occurred in these studies, the tendency was for the glass ionomer cement to fail at the cement/band interface, leaving the cement bonded to the tooth enamel. This evidence might persuade one to argue that orthodontic bands cemented on stainless steel crowns with glass ionomer cement may not have the same inherent potential to be as retentive as similar bands cemented on natural teeth. This may be why some clinicians have reported anecdotal evidence of poor clinical success when placing band and loop space maintainers on stainless steel crown abutments.

Croll in his 1983 technique article on cementing band and loop space maintainers advocated roughening the band interior with a coarse diamond bur to aid cement adherence to the stainless steel.[13] For the roughening phase of this analysis, Unitek regular bands were chosen from Groups I and II, and Unitek narrow bands from Groups III and IV, because these bands performed either superior or equivalent to the others.

Visual examination of the roughened dislodged bands and crowns revealed cement affixed to both the internal band and external crown surfaces where scored. This indicates that a partial cohesive failure of the cement had occurred. Roughening the band/crown interface greatly enhanced the mechanical retention of the glass ionomer cement. The cemented roughened samples had statistically greater mean retention values than when cemented and tested in their original state. Mean retention values increased from 107% to 340% for the subgroups tested.

Bills, Yates and McKnight in their 1980 laboratory study evaluated the retention of stainless steel orthodontic bands cemented with four commonly used dental cements on 120 extracted human premolar teeth.[4] An Instron Universal Testing Machine was used with a technique similar to that utilized in this investigation. At the 24 hour post cementation time period, the results were as follows:

Zinc phosphate	X=38.500 ± 12.85 lbs.
Zinc phosphate with fluoride	X=24.200 ± 8.30 lbs.
Zinc silicophosphate	X=20.600 ± 7.19 lbs.
Polycarboxylate	X=27.000 ± 8.87 lbs.

Norris and co-workers in their 1986 in vitro investigation quantified the retention of stainless steel bands cemented with three commonly used dental cements on 180 extracted human molar teeth.[5] The technique was also similar to the one employed in this study. At the 24 hour post cementation period, the results were:

Zinc phosphate	1.14 MN/m^2	(Range .44-1.57)
Polycarboxylate	0.97 MN/m^2	(Range .31-1.91)
Glass ionomer	0.99 MN/m^2	(Range .31-1.90)

These results are given as force per surface area of the bands. The surface areas were not given. In order to decipher these numbers by converting them to lbs., an assumption was made that the average molar band is 10 mm in diameter and 4 mm in width (height). Using the equation $2\pi r \times h$ to determine the surface area of this hypothetical band and converting from mm to inches, the r=0.1969", the h=0.1575", and the surface area=0.1949 in^2. Given that 1 MN/m^2=145 $lbs./in.^2$, the results of Norris, et. al., can be converted to lbs.:

Zinc phosphate	$X \approx 32.2$ lbs.	(Range 12.4-44.0 lbs.)
Polycarboxylate	$X \approx 27.4$ lbs.	(Range 8.8-54.0 lbs.)
Glass ionomer	$X \approx 28.0$ lbs.	(Range 8.8-53.7 lbs.)

As with the present study, the standard deviations published in the Bills study, and the ranges given in the Norris article are large.

The mean roughened data achieved in this study for the four deciduous molar crown groups are superior to the mean data published from the two previously referenced studies for orthodontic bands cemented to extracted teeth with commonly used dental cements. Though direct comparison is not statistically possible, it is interesting to contemplate.

Cementing band and loop space maintainers on primary and permanent molars is an accepted clinical procedure. From the retention values given in the literature for orthodontic bands cemented to extracted posterior teeth, and from the data presented in this study, it would seem logical to conclude that a clinician would be justified in cementing a band and loop type space maintainer on a deciduous molar stainless steel crown with glass ionomer cement utilizing the roughened band/crown interface technique.

When it becomes clinically appropriate to remove a band and loop space maintainer from a roughened stainless steel crown, a clinically acceptable surface finish can be easily achieved with common dental finishing/polishing burs and devices.

When a factory band cannot be found to fit the smaller sizes of 1st molar crowns, fabricating a custom band using the technique previously described in this paper is a practical alternative. The following list may serve as a quick reference guide to match Unitek primary molar stainless steel crowns with corresponding Unitek orthodontic bands.

Maxillary 2nd Primary Molars	Maxillary 1st Primary Molars
U1 - U29	U1 - CUSTOM
U2 - U29 1/2	U2 - CUSTOM
U3 - U31 1/2	U3 - NL25
U4 - U33	U4 - NL26
U5 - U35	U5 - NL27
U6 - U37	U6 - NU28

Mandibular 2nd Primary Molars	Mandibular 1st Primary Molars
L1 - NL27	L1 - CUSTOM
L2 - L29	L2 - CUSTOM
L3 - L29 1/2	L3 - CUSTOM
L4 - L31 1/2	L4 - NL25
L5 - L33 1/2	L5 - NL26
L6 - L35 1/2	L6 - NL27

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APPENDIX 1

Uniformity of Sample Material

The trim and crimp of the stainless steel crowns utilized in this investigation was compared within groups as follows:

Group I Crowns

Trim - The similarity of trim of 10 randomly selected Group I crowns was evaluated using weight as the factor of comparison (Table i in Appendix 1). All 10 samples weighed fell within ± 2 SD from the mean (X=.288 ± .0024 gm). The range between high and low weights encompassed 2.4% of the mean value, suggesting that the crowns were uniformly trimmed.

Crimp- The similarity of crimp was evaluated using the maximum inside diameter measurements (mesial-buccal to distal-lingual and mesial-lingual to distal-buccal) of 10 randomly selected trimmed and crimped Group I crowns (Table iii in Appendix 1). All measurements fell within ± 2 SD from their corresponding means (X MB-DL=10.85 ± .15 mm and X ML-DB=9.74 ± .09 mm). The range between high and low MB-DL and ML-DB measurements was equal to 4.1% and 2.6% respectively of their corresponding mean values, again verifying the uniformity of the crowns.

Group II Crowns

Trim- All 10 randomly selected trimmed Group II samples weighed fell within ± 2 SD from the mean (X=.2664 ± .0022 gm). The range between high and low weights encompassed 2.6% of the mean value, suggesting that the trimmed crowns were alike (Table i in Appendix 1).

Crimp- The maximum inside diameter MB-DL and ML-DB measurements of 10 randomly selected trimmed and crimped Group II crowns was evaluated. All measurements fell within ± 2 SD from their corresponding means (X MB-DL=9.77 ± .07 mm and X ML-DB=9.32 ± .11 mm). The range between high and low MB-DL and ML-DB measurements was equal to 2.0% and 3.5% respectively of their corresponding mean values (Table iii in Appendix 1).

Group III Crowns

Trim- All 10 randomly selected Group III samples weighed fell within ± 2 SD from the mean (X=.1901 ± .0017 gm). The range between high and low weights encompassed 2.6% of the mean value (Table ii in Appendix 1).

Crimp- The maximum inside diameter MB-DL and ML-DB measurements of 10 randomly selected trimmed and crimped Group III crowns was evaluated. All measurements fell within ± 2 SD from their corresponding means (X MD-DL=8.28 ± .11 mm and X ML-DB=7.14 ± .12 mm). The range between high and low MB-DL and ML-DB measurements was equal to 4.0% and 5.2% respectively of their corresponding mean values, again verifying the uniformity of the crowns (Table iv in Appendix 1).

Group IV Crowns

Trim- Nine of the 10 randomly selected samples weighed fell within ± 2 SD from the mean (X=.1795 ± .0017 gm). The range between high and low weights encompassed 3.3% of the mean value, suggesting the uniformity of the sample crowns (Table ii in Appendix 1).

Crimp- The maximum inside diameter MB-DL and ML-DB measurements of 10 randomly selected trimmed and crimped crowns was evaluated. All measurements fell within ± 2 SD from their corresponding means (X MB-DL=7.96 ± .07 mm and X ML-DB=7.2 ± .07 mm). The range between high and low MB-DL and ML-DB measurements was equal to 2.5% and 2.8% respectively of their corresponding mean values (Table iv in Appendix 1).

APPENDIX 1

TABLE i

Weight in Grams of Randomly Selected Trimmed and Untrimmed Deciduous Molar Crowns

	Unitek UR 2nd #4		Unitek LR 2nd #4	
No.	Trimmed	Untrimmed	Trimmed	Untrimmed
1	.291 g	.311 g	.266 g	.285 g
2	.284	.310	.267	.283
3	.289	.310	.265	.284
4	.284	.310	.268	.284
5	.289	.306	.270	.284
6	.290	.309	.265	.286
7	.287	.308	.267	.286
8	.290	.307	.269	.283
9	.287	.308	.263	.282
10	.289	.310	.264	.285
MEAN	.288	.3089	.2664	.2842
VAR.	.0000060	.0000025	.0000049	.0000017
STD.DEV	.002449	.001595	.002221	.001316
SEM	.000775	.000504	.000702	.000416

	Trimmed	Trimmed
Range:	L=.284, H=.291	L=.263, H=.270
Difference:	.007 = 2.4% of X	.007 = 2.6% of X

X ± 2 SD: .2880 ± .0048=.2832-.2928 / .2664 ± .0044=.2620-.2708

All trimmed crowns weighed are within ± 2 Sd of their respective means.

APPENDIX 1

TABLE ii

Weight in Grams of Randomly Selected Trimmed and Untrimmed Deciduous Molar Crowns

	Unitek UR 1st #4		Unitek LR 1st #4	
No.	Trimmed	Untrimmed	Trimmed	Untrimmed
1	.188 g	.203 g	.178 g	.198 g
2	.190	.205	.179	.199
3	.191	.204	.179	.200
4	.187	.204	.180	.200
5	.191	.204	.181	.199
6	.191	.204	.179	.200
7	.190	.203	.177	.199
8	.191	.203	.179	.201
9	.193	.205	.183	.199
10	.189	.203	.180	.201
MEAN	.1901	.2038	.1795	.1996
VAR.	.0000030	.0000006	.0000027	.0000009
STD.DEV	.001729	.000789	.001650	.000966
SEM	.000546	.000249	.000522	.000305

	Trimmed	Trimmed
Range:	L=.188, H=.193	L= .177, H=.183
Difference:	.005 = 2.6% of X	.006 = 3.3% of X

X ± 2 SD: .1901 ± .0035=.1866-.1936 / .1795 ± .0033=.1762-.1828

All trimmed crowns weighed, except one, are within ± 2 SD of their respective means.

APPENDIX 1

TABLE iii

Inside Transverse Diameter Measurements at the Gingival Margin of Trimmed and Crimped Crowns

	Unitek UR2nd #4		Unitek LR 2nd #4	
No.	MB-DL	ML-DB	MB-DL	ML-DB
1	11 mm	9.8 mm	9.7 mm	9.4 mm
2	10.9	9.6	9.8	9.2
3	11*	9.7*	9.7*	9.35*
4	10.8	9.8	9.8	9.3
5	10.85*	9.7	9.7	9.2
6	10.8	9.85*	9.8	9.3
7	10.7	9.7	9.9*	9.45*
8	10.9	9.8	9.73*	9.17*
9	10.55*	9.6*	9.8	9.5
10	11	9.8	9.8	9.3
MEAN	10.85	9.735	9.773	9.317
VAR.	.02111	.00781	.00418	.01211
STD.DEV	.1453	.0883	.0646	.1101
SEM	.0459	.0279	.0204	.0348

*=X of three separate measurements.

MB-DL

Range: L=10.55, H=11.0 / L=9.7, H=9.9
Difference: .45 = 4.1% of X / .2 = 2.0% of X
X ± 2 SD: 10.85 ± .29= 10.56-11.14 / 9.773 ±.129= 9.64-9.90

ML-DB

Range: L=9.6, H=9.85 / L=9.17, H=9.5
Difference: .25 = 2.6% of X / .33 = 3.5% of X
X ± 2 SD: 9.735 ± .177= 9.56-9.91 / 9.317 ± .220= 9.10-9.54

APPENDIX 1

TABLE iv

Inside Transverse Diameter Measurements at the Gingival Margin of Trimmed and Crimped Crowns

	Unitek UR 1st #4		Unitek LR 1st #4	
No.	MB-DL	ML-DB	MB-DL	ML-DB
1	8.4*mm	7.2*mm	8.0 mm	7.2 mm
2	8.2	7.3	8.0	7.2
3	8.2	7.1	8.1	7.2
4	8.3	7.0	7.9	7.2
5	8.3	7.1	7.9	7.1
6	8.2	7.4	8.0	7.2
7	8.17*	7.03*	7.9	7.1
8	8.2	7.1	7.9	7.3
9	8.5	7.1	7.9	7.3
10	8.3	7.1	8.0	7.2
MEAN	8.277	7.143	7.960	7.200
VAR.	.01129	.01516	.00489	.00444
STD.DEV	.1063	.1231	.0699	.0667
SEM	.0336	.0389	.0221	.0211

*=X of three separate measurements.

MB-DL

Range:	L=8.17, H=8.5	L=7.9, H=8.1
Difference:	.33 = 4.0% of X	.20 = 2.5% of X
X ± 2 SD:	8.277 ±.212= 8.07-8.49 /	7.96 ± .140= 7.82-8.10

ML-DB

Range:	L=7.03, H=7.4	L=7.1, H=7.3
Difference:	.37 = 5.2% of X	.2 = 2.8% of X
X ± 2 SD:	7.143 ±.246= 6.90-7.40 /	7.2 ± .134= 7.07-7.33

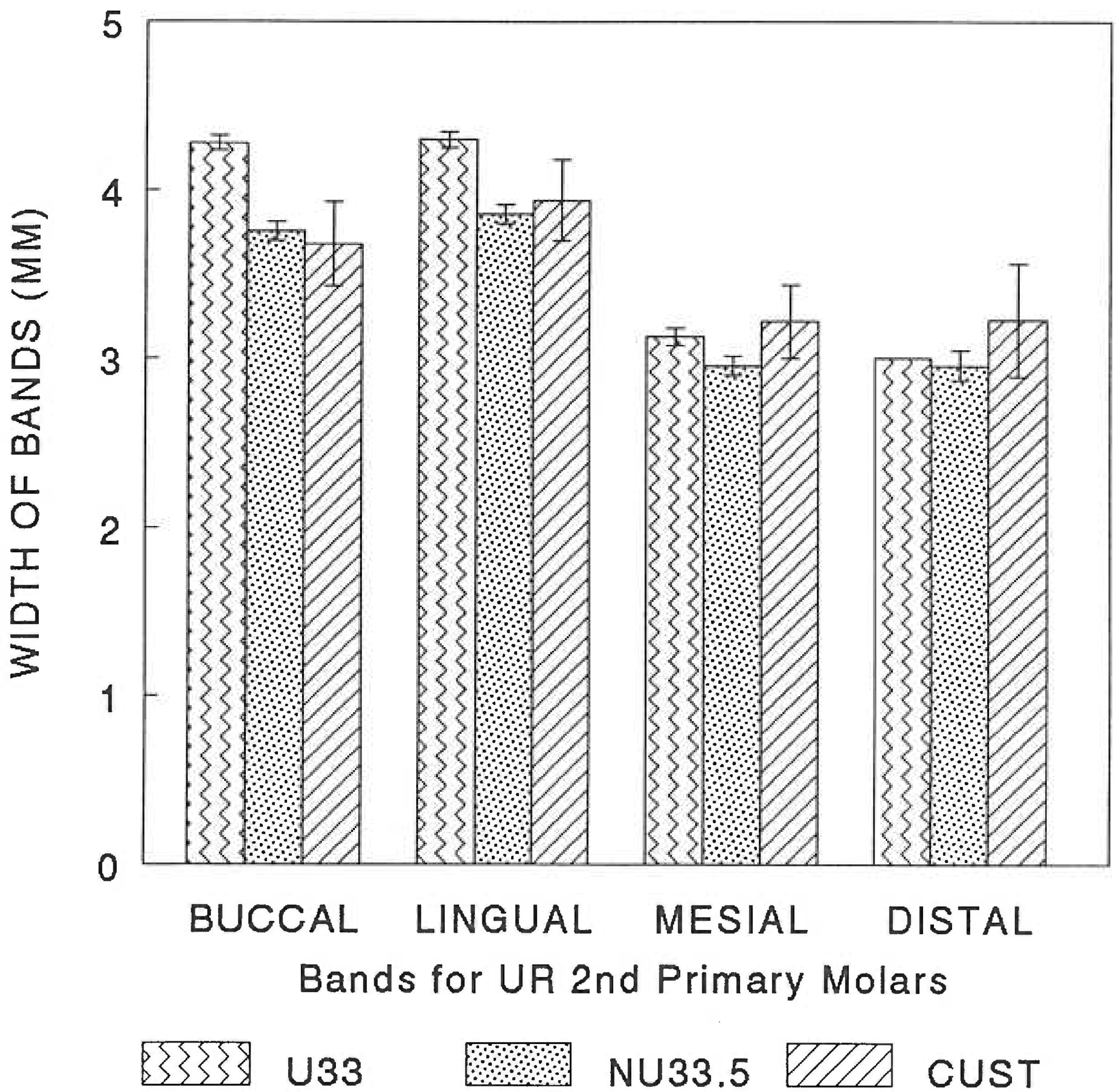
APPENDIX 1

Band Comparison

The custom bands were measured and graphically compared with similar diameter Unitek factory bands used in this study (Figures v-viii and Tables v-viii in Appendix 1). The custom bands, though varying from the factory bands, were quite similar to their factory counterparts. In many instances the custom bands were wider than the Unitek narrow bands.

APPENDIX 1, FIGURE v

Custom vs. Unitek Band Widths



APPENDIX 1

TABLE v-a

Unitek U33 Band Width Measurements

No.	Buccal	Lingual	Mesial	Distal
1	4.3 mm	4.3 mm	3.2 mm	3.0 mm
2	4.3	4.3	3.1	3.0
3	4.2	4.3	3.1	3.0
4	4.3	4.3	3.2	3.0
5	4.3	4.3	3.1	3.0
6	4.3	4.2	3.1	3.0
7	4.2	4.4	3.1	3.0
8	4.3	4.3	3.2	3.0
9	4.3	4.3	3.1	3.0
10	4.3	4.3	3.1	3.0
MEAN	4.28	4.3	3.13	3
VAR.	.00178	.00222	.00233	
STD.DEV	.0422	.0471	.0483	
SEM	.0133	.0149	.0153	

APPENDIX 1

TABLE v-b

Unitek NU33 1/2 Band Width Measurements

No.	Buccal	Lingual	Mesial	Distal
1	3.7 mm	3.8 mm	3.0 mm	3.1 mm
2	3.8	3.9	3.0	2.9
3	3.8	3.8	2.9	3.0
4	3.8	3.9	3.0	2.9
5	3.7	3.9	2.9	2.9
6				
7				
8				
9				
10				
MEAN	3.76	3.86	2.96	2.96
VAR.	.003	.003	.003	.008
STD.DEV	.0548	.0548	.0548	.0894
SEM	.0245	.0245	.0245	.0400

APPENDIX 1

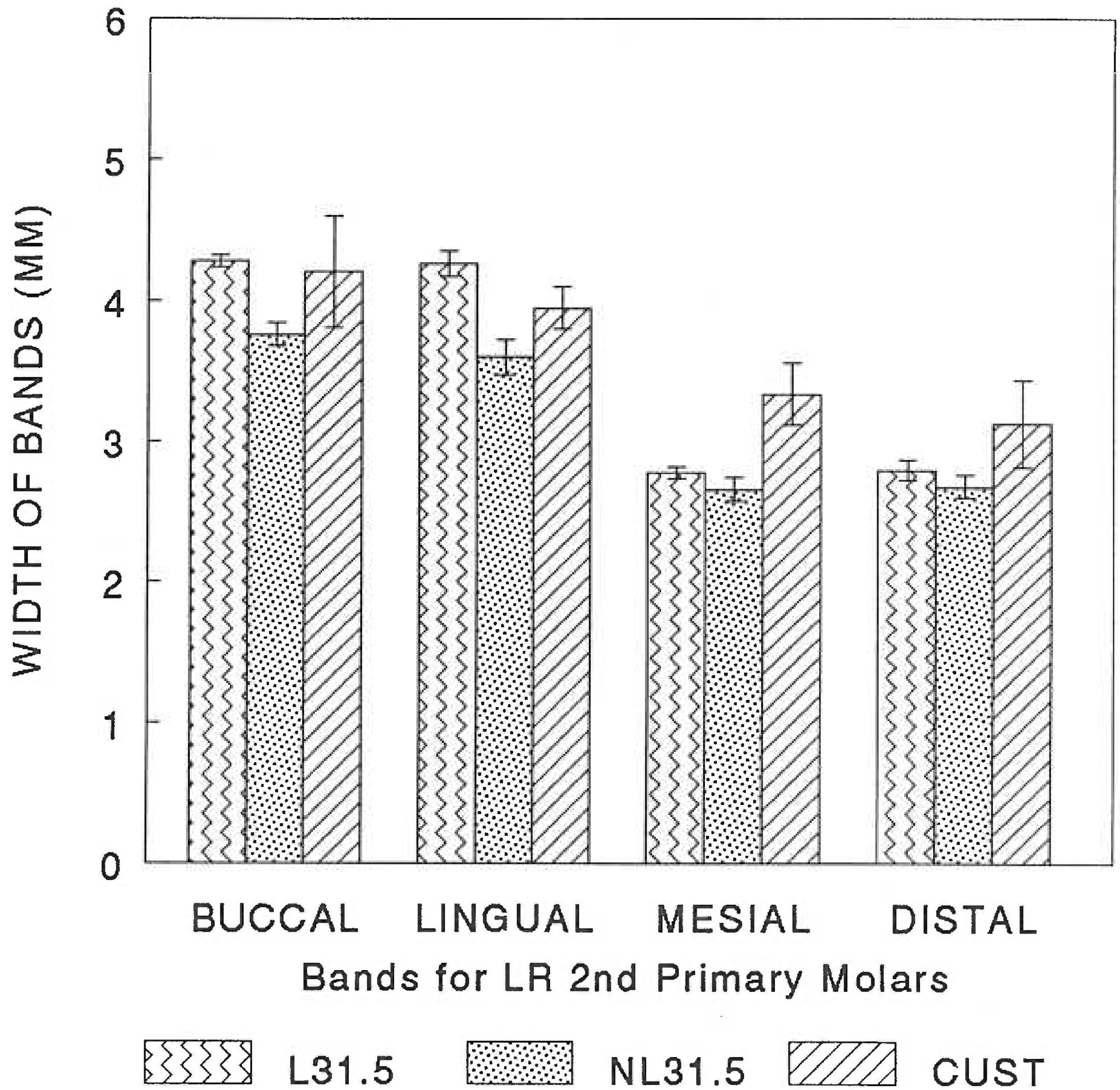
TABLE v-c

UR 2nd Custom Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	3.9 MM	3.9 MM	3.4 MM	3.0 MM
2	4.2	4.2	3.4	3.7
3	3.6	4.1	3.6	3.1
4	3.6	3.9	3.1	3.4
5	3.4	4.0	3.0	3.3
6	3.6	3.7	3.1	2.8
7	3.7	4.0	3.0	3.5
8	3.7	4.1	3.2	3.6
9	3.3	3.4	3.0	2.7
10	3.8	4.1	3.4	3.2
MEAN	3.68	3.94	3.22	3.23
VAR.	.0640	.0560	.0462	.1112
STD.DEV	.2530	.2366	.2150	.3335
SEM	.0800	.0748	.0680	.1055

APPENDIX 1, FIGURE vi

Custom vs. Unitek Band Widths



APPENDIX 1

TABLE vi-a

Unitek L31 1/2 Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	4.3 mm	4.2 mm	2.7 mm	2.7 mm
2	4.3	4.4	2.8	2.8
3	4.3	4.3	2.8	2.9
4	4.3	4.2	2.8	2.8
5	4.2	4.2	2.8	2.8
6				
7				
8				
9				
10				
MEAN	4.28	4.26	2.78	2.8
VAR.	.002	.008	.002	.005
STD.DEV	.0447	.0894	.0447	.0707
SEM	.0200	.0400	.0200	.0316

APPENDIX 1

TABLE vi-b

Unitek NL31 1/2 Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	3.7 mm	3.5 mm	2.7 mm	2.8 mm
2	3.6	3.6	2.8	2.7
3	3.8	3.8	2.6	2.6
4	3.6	3.6	2.6	2.7
5	3.7	3.5	2.6	2.6
6				
7				
8				
9				
10				
MEAN	3.68	3.6	2.66	2.68
VAR.	.007	.015	.008	.007
STD.DEV	.0837	.1225	.0894	.0837
SEM	.0374	.0548	.0400	.0374

APPENDIX 1

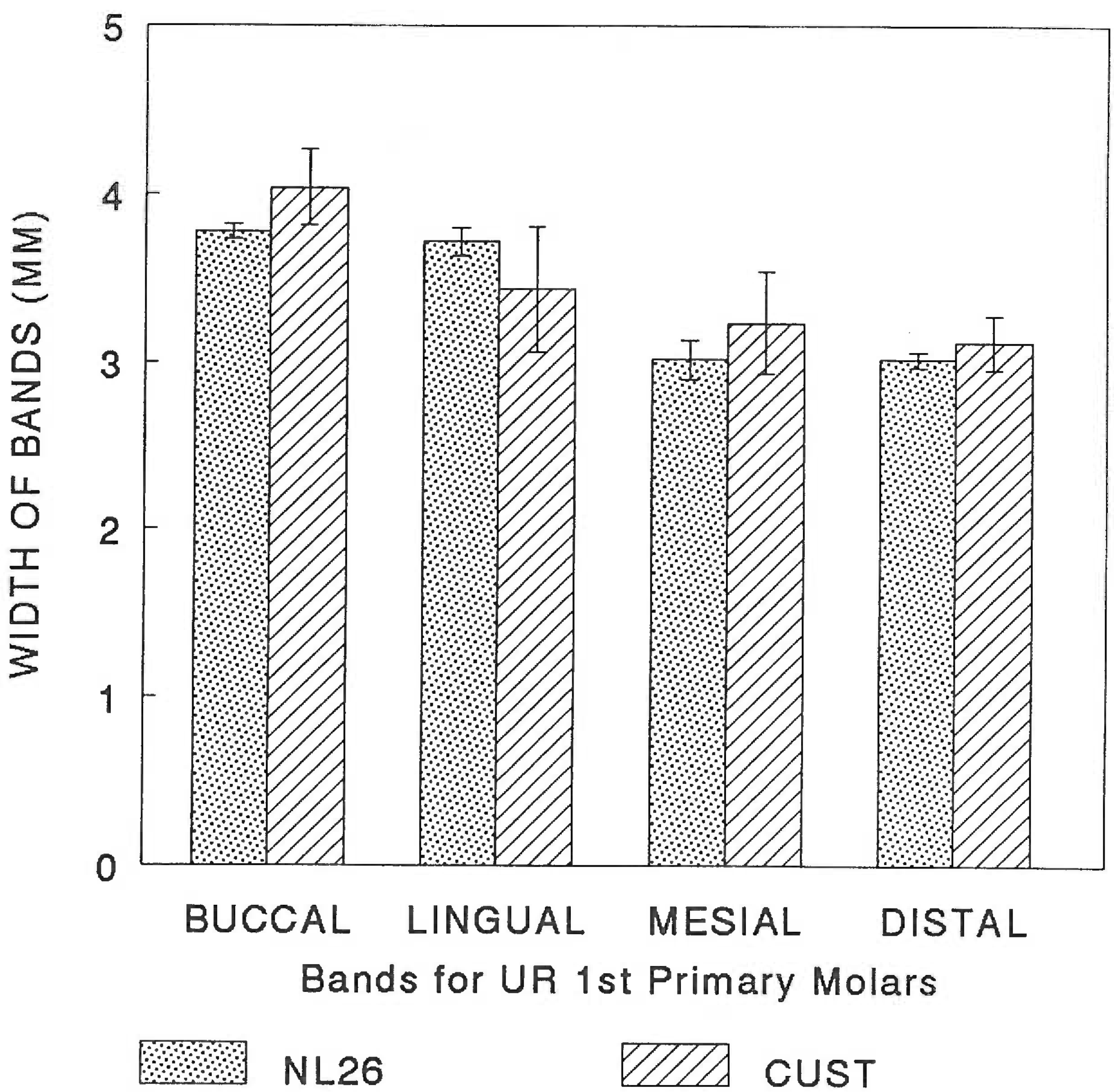
TABLE vi-c

LR 2nd Custom Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	4.4 mm	3.8 mm	3.4 mm	3.6 mm
2	4.0	4.0	3.3	2.8
3	3.6	3.8	3.1	3.1
4	3.9	4.0	3.6	2.8
5	4.3	4.1	3.5	3.2
6	4.6	4.1	3.0	3.4
7	4.5	3.8	3.3	3.1
8	4.6	4.2	3.3	3.5
9	3.6	3.8	3.2	2.7
10	4.5	3.9	3.7	3.1
MEAN	4.2	3.95	3.34	3.13
VAR.	.1556	.0228	.0471	.0934
STD.DEV	.3944	.1509	.2171	.3057
SEM	.1247	.0477	.0686	.0967

APPENDIX 1, FIGURE vii

Custom vs. Unitek Band Widths



APPENDIX 1

TABLE vii-a

Unitek NL26 Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	3.8 mm	3.8 mm	3.1 mm	3.1 mm
2	3.7	3.6	3.1	3.0
3	3.8	3.8	2.9	3.0
4	3.8	3.7	2.9	3.0
5	3.8	3.7	3.1	3.0
6				
7				
8				
9				
10				
MEAN	3.78	3.72	3.02	3.02
VAR.	.002	.007	.012	.002
STD.DEV	.0447	.0837	.1095	.0447
SEM	.0200	.0374	.0490	.0200

APPENDIX 1

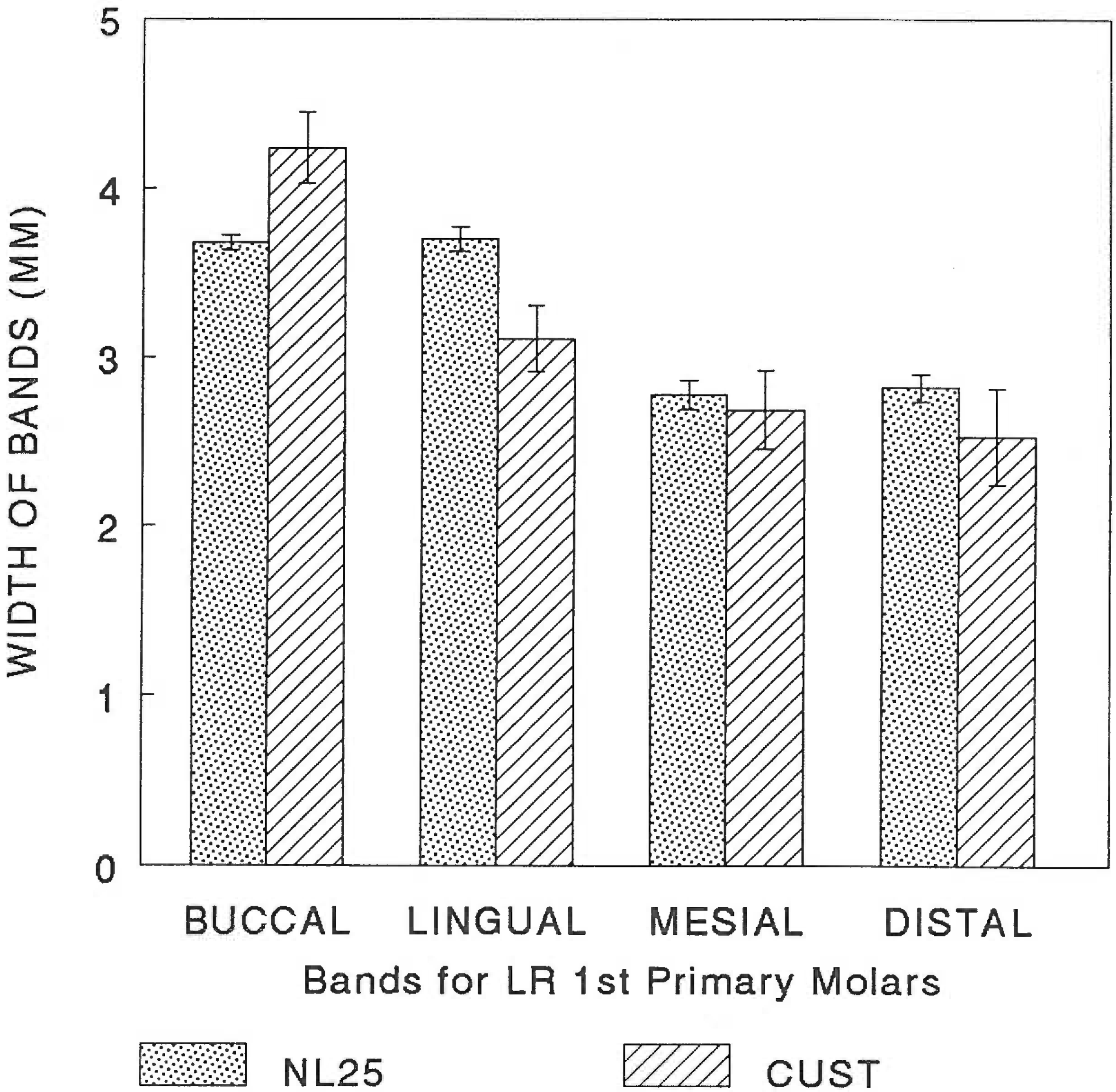
TABLE vii-b

UR 1st Custom Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	4.0 mm	3.7 mm	3.3 mm	3.3 mm
2	4.2	3.6	3.4	3.2
3	4.3	3.6	3.4	3.2
4	4.4	2.7	2.6	3.3
5	4.0	3.3	3.2	3.0
6	4.1	3.0	2.9	3.3
7	4.1	3.3	3.7	2.9
8	3.8	3.9	3.4	3.1
9	3.8	3.5	3.3	3.0
10	3.7	3.8	3.2	2.9
MEAN	4.04	3.44	3.24	3.12
VAR.	.0516	.1382	.0916	.0262
STD.DEV	.2271	.3718	.3026	.1619
SEM	.0718	.1176	.0957	.0512

APPENDIX 1, FIGURE viii

Custom vs. Unitek Band Widths



APPENDIX 1

TABLE viii-a

Unitek NL25 Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	3.7 mm	3.7 mm	2.8 mm	2.8 mm
2	3.6	3.7	2.8	2.7
3	3.7	3.6	2.7	2.9
4	3.7	3.7	2.7	2.9
5	3.7	3.8	2.9	2.8
6				
7				
8				
9				
10				
MEAN	3.68	3.7	2.78	2.82
VAR.	.002	.005	.007	.007
STD.DEV	.0447	.0707	.0837	.0837
SEM	.0200	.0316	.0374	.0374

APPENDIX 1

TABLE viii-b

LR 1st Custom Band Width Measurements

No.	BUCCAL	LINGUAL	MESIAL	DISTAL
1	4.3 mm	3.0 mm	2.3 mm	2.9 mm
2	4.3	3.5	2.9	2.8
3	4.1	3.1	2.8	2.2
4	3.8	3.0	2.5	2.4
5	4.4	3.2	3.0	2.2
6	4.4	3.0	2.7	2.4
7	4.3	3.2	2.9	2.2
8	4.3	2.8	2.4	2.6
9	4.5	3.0	2.8	2.8
10	4.0	3.3	2.6	2.8
MEAN	4.24	3.11	2.69	2.53
VAR.	.0449	.0388	.0543	.0801
STD.DEV	.2119	.1969	.2331	.2830
SEM	.0670	.0623	.0737	.0895

APPENDIX 1

Angulation of machine screws

The amount of variation within the sample population with respect to the angulation of the machine screw away from the long axis of its sample crown was measured (Table ix of Appendix 1). Three randomly selected samples were chosen from each of the twelve subgroups. The greatest angulation of the machine screw away from perpendicular to the occlusal plane of each crown was measured using a simple plastic protractor for each of the 36 randomly selected samples. The mean angulation was 2.9 degrees with a standard deviation (SD) of 1.5 degrees. The range was 0-5 degrees for the samples measured. This amount of angulation from perpendicular should have been compensated for by the Instron's universal joint.

APPENDIX 1

TABLE ix

Angulation of Machine Screws from Perpendicular
for 36 Randomly Selected Samples

No.	No.	NO.	NO.	
1. 5 deg.	10. 4	19. 3	28. 3	
2. 1	11. 2	20. 4	29. 2	
3. 5	12. 1	21. 2	30. 4	
4. 3	13. 1	22. 3	31. 4	
5. 1	14. 3	23. 3	32. 5	
6. 1	15. 5	24. 4	33. 1	
7. 2	16. 4	25. 2	34. 1	
8. 3	17. 5	26. 3	35. 0	
9. 1	18. 4	27. 3	36. 5	
MEAN			2.86	
VAR.			2.19	
STD.DEV			1.48	
SEM			.25	

APPENDIX 2

TABLE 1

Unitek #4 Maxillary Right Deciduous 2nd Molar
Molar Stainless Steel Crowns

Orthodontic Bands Tested

No.	Unitek U33	Unitek NU 33 1/2	Rocky Mt. 6.5	Custom
1	15 lbs.	32 lbs.	23.5 lbs.	9 lbs.
2	39	23.5	25.5	13.5
3	30.5	44.5	19.5	9
4	34	25	26.5	14.5
5	34	35.5	25.5	11.5
6	25.5	26.5	22	14.5
7	29	18.5	19	12.5
8	19	14	15.5	21.5
9	24	15	18.5	7.5
10	32.5	16.5	28	9.5
MEAN	28.25	25.1	22.35	12.3
VAR.	54.6806	97.7111	16.8361	16.5667
STD.DEV	7.3946	9.8849	4.1032	4.0702
SEM	2.3384	3.1259	1.2975	1.2871

Kwikstat 2.10 Statistical Program

ANOVA Table

Source	SS	DF	MS	F
Total	3099.79	39		
Between	1427.60	3	475.87	10.24
Within	1672.19	36	46.45	

Table value for F at α=.05 with 3:36 df=3.23; at α=.01 F=5.18.

A Newman-Keuls multiple comparisons test revealed that the U33, NU 33 1/2, and RM U6.5 subgroups were statistically the same, while the Custom subgroup was statistically different.

APPENDIX 2

TABLE 1 STATISTICAL ANALYSIS CONT.

F tests for homogeneity of variance:

Table value for F at $\alpha=.05$ with df (9:9) = 3.18.

U33 and NU33 1/2 subgroups have homogeneity of variance (F=1.79).
RM U6.5 and Custom subgroups have homogeneity of variance (F=1.02).
U33 and RM U6.5 do not (F=3.25).

To verify ANOVA results due to the lack of homogeneity of variance between some of the Group I subgroups, selected t tests were run at an $\alpha=.01$ using corrected table values as described by Phillips [9], where indicated.

U33 vs. RM U6.5: t=2.21

Corrected table value for t at $\alpha=.01$ with 18 df is 3.24.
At $\alpha=.05$ it is 2.26.

The U33 and RM U6.5 subgroups are statistically the same.

RM U6.5 vs. Custom: t=5.49

Table value for t at $\alpha=.01$ with 18 df is 2.88.
At $\alpha=.05$ it is 2.10.

The RM U6.5 and Custom subgroups are statistically different.

ANOVA is verified.

*Note: An $\alpha=.01$ was used for multiple t testing because the error is additive.

APPENDIX 2

TABLE 2

Unitek #4 Mandibular Right Deciduous 2nd Molar Stainless Steel Crowns

Orthodontic Bands Tested

No.	Unitek L 31 1/2	Unitek NL 31 1/2	Rocky Mt. 4.5	Custom
1	12 lbs.	7 lbs.	24.5 lbs.	21.5 lbs.
2	22.5	10	8.5	23
3	12	4	11.5	24.5
4	10.5	5.5	22	11
5	20	6	25.5	17
6	28.5	5	9	10
7	13	5.5	25	15.5
8	12.5	7.5	13.5	16.5
9	11.5	8	16.5	14
10	10	5.5	11.5	15
MEAN	15.25	6.4	16.75	16.8
VAR.	38.7361	3.0444	47.3472	23.6222
STD.DEV	6.2238	1.7448	6.8809	4.8603
SEM	1.9681	.5518	2.1759	1.5370

Kwikstat 2.10 Statistical Program

ANOVA	SS	DF	MS	F
Total	1760.41	39		
Between	745.65	3	248.55	8.82
Within	1014.76	36	28.19	

Table value for F at α=.05 with 3:36 df=3.23; at α=.01 F=5.18.

A Newman-Keuls multiple comparisons test revealed that the L31 1/2, RM L4.5, and Custom subgroups were statistically the same, while the NL31 1/2 subgroup was statistically different.

APPENDIX 2

TABLE 2 STATISTICAL ANALYSIS CONT.

F tests for homogeneity of variance:

Table value for F at α=.05 with df (9.9) = 3.18.

RM L4.5 and Custom subgroups have homogeneity of variance (F=2.00). NL31 1/2 and Custom do not (F=7.76).

Verification of ANOVA due to lack of homogeneity of variance:

L31 1/2 vs. NL31 1/2: t = 4.34

Corrected table value for t at α=.01 with 18 df is 2.26. At α=.01 it is 3.25.

The L31 1/2 and NL31 1/2 subgroups are statistically different.

ANOVA is verified.

APPENDIX 2

TABLE 3

Unitek #4 Maxillary Right Deciduous 1st
Molar Stainless Steel Crowns

Orthodontic Bands Tested

No.	Unitek NL26		Custom	
1	17.5 lbs.		17 lbs.	
2	10		17.5	
3	19		21.5	
4	14.5		16	
5	22.5		19.5	
6	20		21	
7	16		19	
8	21.5		16	
9	18.5		14	
10	11		16	
MEAN	17.05		17.75	
VAR.	17.5806		5.9028	
STD.DEV	4.1929		2.4296	
SEM	1.3259		.7683	

F test for homogeneity of variance = 2.98.
Table value for F at α=.05 with df (9:9) = 3.18
The NL26 and Custom subgroups exhibit homogeneity of variance.

NL26 vs. Custom: t = .46
Table value for t at α=.05 with 18 df = 2.101.

The NL26 and Custom subgroups are statistically the same.

APPENDIX 2

TABLE 4

Unitek #4 Mandibular Right Deciduous 1st
Molar Stainless Steel Crowns

Orthodontic Bands Tested

No.	Unitek NL25		Custom	
1	20 lbs.		15 lbs.	
2	18		16.5	
3	20.5		10.5	
4	24.5		13	
5	21.5		5	
6	25.5		8	
7	19.5		13	
8	21		13	
9	20		19.5	
10	13		15	
MEAN	20.35		12.85	
VAR.	11.7806		17.5028	
STD.DEV	3.4323		4.1836	
SEM	1.0854		1.3230	

F test for homogeneity of variance = 1.49.
Subgroups exhibit homogeneity of variance.

NL25 vs Custom: t = 4.38
Table value for t at α=.05 with 18 df = 2.101.
The NL25 subgroup is statistically different from the Custom subgroup.

APPENDIX 2

TABLE 5A

Roughened Band Crown Interface

Orthodontic Bands Tested

No.	L 2ND SSC-Custom	L 2nd SSC-Unitek L31 1/2	U 2nd SSC-Unitek U33	
1	68 lbs.	59 lbs.	50 lbs.	
2	43	61	55	
3	93	59	62	
4	68	52	84	
5	86	85	47	
6	86	33	54	
7	49	78	65	
8	110	69	39	
9	74	42	71	
10	63	72	60	
MEAN	74	61	58.7	
VAR.	413.7778	253.7778	164.4556	
STD.DEV	20.3415	15.9304	12.8240	
SEM	6.4326	5.0376	4.0553	

U33 Subgroup:
t test on repeated measures: $t = 7.81$.
Table value for t at $\alpha=.05$ with 9 df = 2.262.

All subgroups tested statistically superior after roughening.

Roughened L 2nd Cust vs. L31 1/2: $t = 1.59$.
Table value for t at $\alpha=.05$ with 18 df = 2.101.
The roughened L 2nd Custom and L31 1/2 subgroups tested statistically the same.

APPENDIX 2

TABLE 5B

Roughened Band Crown Interface

Orthodontic Bands Tested

No.	U 1ST SSC- Unitek NL26		L 1st SSC- Unitek NL25	
1	81 lbs.		43 lbs.	
2	70		47	
3	77		63	
4	60		43	
5	72		49	
6	81		56	
7	59		63	
8	77		50	
9	77		59	
10	82		56	
MEAN	73.6		52.9	
VAR.	69.8222		57.2111	
STD.DEV	8.3560		7.5638	
SEM	2.6424		2.3919	

APPENDIX 3

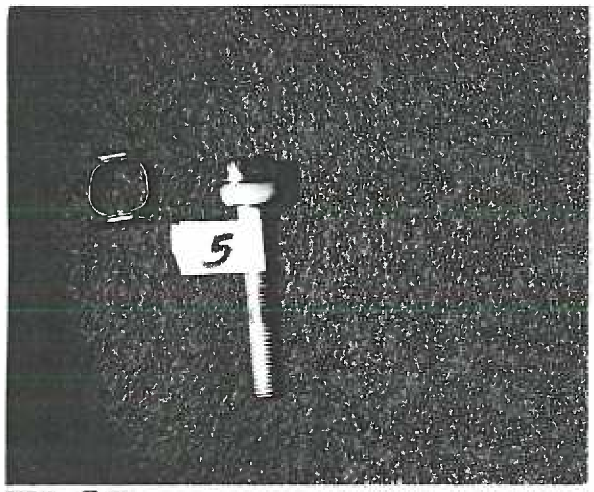


Figure 1

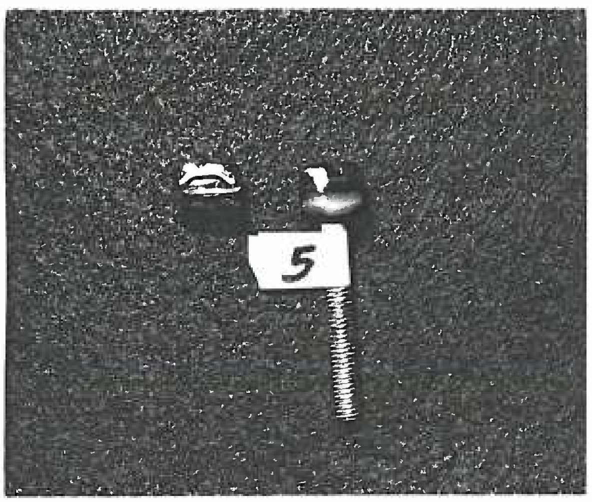


Figure 2

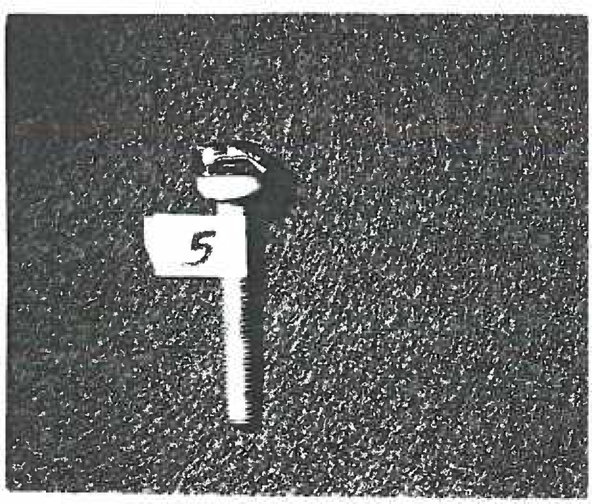


Figure 3

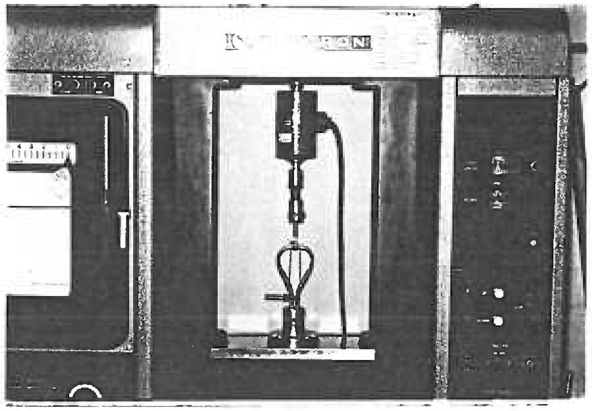


Figure 4

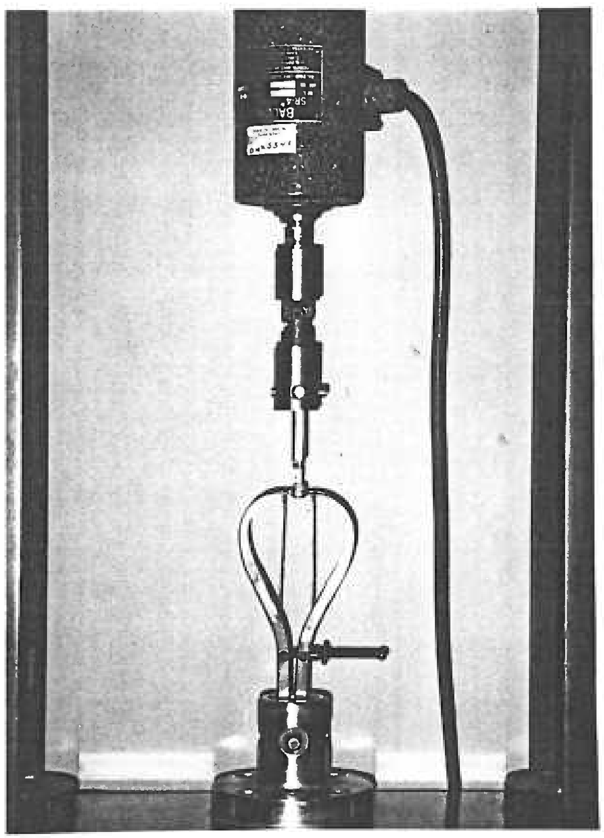


Figure 5

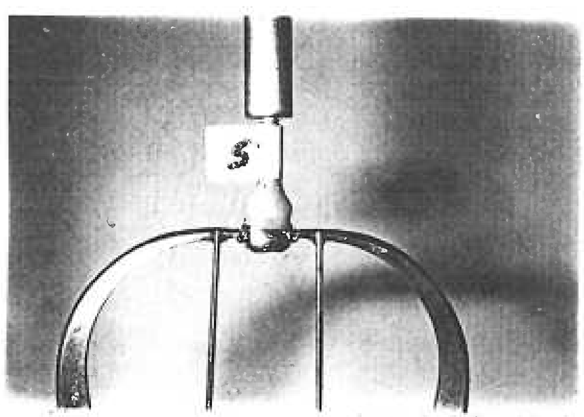


Figure 6