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Original Article

The duration of fixed orthodontic treatment: a comparison of two groups of patients treated using Edgewise brackets with 0.018" and 0.022" slots

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The duration of fixed appliance Edgewise orthodontic treatment times using brackets with 0.018" and 0.022" slots was measured to determine whether there were any clinically or statistically significant differences between the two appliances. Sixty-four consecutively treated, fully banded patients were selected from two different practice locations. All 64 patients were treated by one clinician. Thirty-two patients (Group 1) were treated using the 0.018" slot bracket and 32 (Group 2) were treated using the 0.022" slot bracket. The patients in each group were treated to the same standard of care using the same technique. The mean duration of treatment for Group 1 was 20.2 months and for Group 2, 21.7 months. Although the mean difference (1.5 months) was not clinically significant, it was statistically significant at $p < 0.05$.

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Introduction

One of the most common questions asked of orthodontists by their patients or their parents is: "How long will treatment last?" In an attempt to provide an effective treatment procedure and to relieve the patient of the stresses of wearing fixed appliances, several investigations have been conducted to try to isolate the factors that may have a bearing on treatment time.

In 1994, Shelton *et al.*[1] compared treatment times using the standard Begg and Tip Edge techniques, and reported that the average treatment time using the Tip Edge technique was 12.8 months and the standard Begg technique, 20.9 months. In 1990, Vig,[2] comparing treatment times in extraction and non-extraction cases selected from five practices, recorded treatment times ranging from 24.8 to 38.6 months and from 17.5 to 34.8 months, respectively. He did not record the archwire dimensions nor the slot sizes used. In 1992, Fink and Smith[3] recorded an average treatment time of 23.1 months, the means ranging from 19.4 to 27.9 months; however, 39 per cent of these cases were extraction cases and 32 per cent had had headgear treatment. They reported that operators spend a wide range of times detailing the finishing of their cases. They also did not record the archwire and bracket slot sizes used in their study. In 1988, Alger,[4] using brackets with 0.018" slots and 0.018" nickel titanium wires, followed by 0.018" x 0.025" stainless steel retraction and/or finishing arches, reported a mean duration of 22.0 months, ranging from 19 to 30 months (including surgical cases), and an average number of appointments of 15.9. He found that extraction cases took an average of 4.6 months longer to treat. The mean duration of fixed orthodontic treatment has been reported as being a minimum of 12.8 months[1] and a maximum of 31.3 months.[3]

The studies of Vig[2] and Fink and Smith[3] tried to assess the effect various patient variables may have on the duration of treatment, such as the age of the patient at the start of treatment, initial ANB angle, the mandibular plane angle, the severity of the initial malocclusion and the number of broken appointments during treatment. The correlation between individual factors and treatment time was small; however, when all factors were combined, the best correlation was still less than 0.5.[3] Both studies used results from patients treated by different clinicians, thereby introducing another variable. In contrast, in the studies conducted by Shelton *et al.*[1] comparing the Begg and Tip-Edge techniques, the non-extraction patients were treated by one operator, but the two groups were not treated concurrently.

Cobb,[5] in a recent (1998) study assessed the achievement of alignment using different wires in conjunction with either a 0.018" or 0.022" slot bracket, in a group of 123 patients treated by nine operators. He compared two groups of patients, one of which had been fitted with 0.018" slot brackets with a mix of single and twin wings (the twin brackets having longer slots) and the other fitted with 0.022" slot twin-wing brackets entirely on the lower arch. He found that the rate of early alignment was significantly faster only in the lower arch of patients treated using the 0.022" slot bracket, the difference being approximately one month in favour of that bracket.

More recently (1999), Kusy[6] investigated the influence of archwire and bracket dimensions on sliding mechanics, emphasising the importance of the critical contact angle between the archwire and the interior of the bracket slot. It is felt that this factor has a bearing on the results of the present study, the aim of which was to assess any difference in the duration of orthodontic treatment of patients with similar malocclusions, treated concurrently by the same clinician, using either a 0.018" or 0.022" slot bracket.

Materials and methods

Sixty-four consecutively treated fully-banded patients were selected from a group of seventy patients. Thirty-two patients (Group 1) were treated using a bracket with a 0.018" slot and 32 (Group 2) were treated using a bracket with a 0.022" slot. Six patients were excluded from the study because either they had had previous first-stage orthodontic treatment or three or more broken appointments that were not rescheduled within a week.

Characteristics of the group, such as sex distribution, type of malocclusion and the number and type of extractions, are presented in Table I. The age at start of treatment, ANB angle, mandibular plane angle, overbite, overjet, age at completion of treatment and the duration of treatment for each patient in both groups are presented in Table II.

The percentage of males and females was similar in both groups, there being 37.5 per cent males in Group 1 and 28.1 per cent in Group 2 (Table I).

The mean age of patients at the beginning of treatment was 15.6 years in Group 1 and 14.9 years in Group 2 (Table II). The age range at the beginning of treatment was also similar for the

Table I. Descriptive statistics for each group: categorical variables.

	Group 1 (0.018") n=32		Group 2 (0.022") n=32		Total n=64	
	Number	%	Number	%	Number	%
Male patients	12	37.5	9	28.1	21	32.8
Female patients	20	62.5	23	71.9	43	67.2
Headgear used	1	3.1	2	6.3	3	4.7
Impacted canines	0	0	1	3.1	1	1.6
Surgical cases	1	3.1	0	0	1	1.6
Extractions (all types)	26	81.2	25	78.1	51	79.7
Incisor extractions	2	6.3	2	6.3	4	6.3
Two premolar extraction	6	18.8	3	9.4	9	14.1
Four premolar extraction	18	56.3	20	62.5	38	59.4
Class I	13	40.6	16	50.0	29	45.3
Class II Division 1	11	34.4	7	21.9	18	28.1
Class II Division 2	4	12.5	2	6.3	6	9.4
Class III	4	12.5	7	21.9	11	17.2

two groups, although Group 1 patients had a higher upper age limit, Group 1 ranging from 11.8 to 31.8 years and Group 2, from 10.9 to 23.6 years.

The mean ANB angle for Group 1 at the start of treatment was 3.4 degrees, compared with 2.9 degrees for Group 2. The mean mandibular plane angle for both groups was the same, at 33.4 degrees (Table II).

All 64 patients were treated by one clinician (C.A.) between January 1995 and December 1997. Thirty-two patients were treated at one practice location, using Roth prescription Miniature Twin* Edgewise brackets with a 0.018" slot (Group 1); and thirty-two patients were treated at another practice location, using Roth prescription Spectrum† Edgewise brackets with a 0.022" slot (Group 2). The bracket widths differed only in the width of the maxillary canine brackets, Group 1 being 3.5 mm wide and Group 2, 3.0 mm wide. None of the patients in either group had had previous treatment using headgear, nor previous functional appliance treatment.

The patients in each group were treated to the same standard of care and with a similar technique. The initial aligning archwire in both groups was a 0.014" NiTi wire, with the final wire in Group 1 being 0.017" x 0.025" stainless steel (Table V), and in Group 2, 0.019" x 0.025" stainless steel (Table VI).

The PAR index[7] was used to assess the quality of the finished results. All cases were treated to a PAR index score of 5 or less. Space closure in both groups was achieved by sliding mechanics, using power chains and intra-oral elastics in conjunction with the stainless steel archwires. Closing loops were not used. Both groups of patients were seen for routine adjustment appointments at five-weekly intervals; however, some patients were seen more often to repair broken archwires and broken brackets.

The mean number of visits and the mean number of broken appointments are recorded in Table II. The mean duration of treatment for each of the malocclusion groups is shown in Table III.

Statistical analysis

The statistical analysis for the study involved calculating the difference between two independent sample means for the duration of treatment. Because N > 30, a *z*-test was used to test the null hypothesis[8] H0: m1 = m2 at $p < 0.05$ (where H0 is the null hypothesis, m1 is the mean duration of treatment for Group 1 and m2 is the mean duration of treatment for Group 2). The mean duration of treatment between the groups as a function of malocclusion type was also assessed using paired *t*-tests.[8]

Table II. Means and standard deviations for variables measured for each patient within each group.

	Group 1 (0.018") n=32		Group 2 (0.022") n=32	
	$\bar{x}$	SD	$\bar{x}$	SD
Treatment time (months)	20.2	3.1	21.7	3.5
Total office visits	18.9	4.1	21.4	3.6
Age (pre-treatment in years)	15.6	4.1	14.9	2.6
Age (post-reatment in years)	17.3	2.6	16.7	2.5
ANB (pre-treatment)	3.4	2.3	2.9	1.8
MP (pre-treatment)	33.4	4.2	33.4	4.8
Overbite (pre-treatment)	2.7	1.7	2.5	2.2
Overjet (pre-treatment)	3.1	1.2	3.1	1.8
Wits (pre-treatment)	+0.5	2.9	-1.6	3.1
Number of broken appointments	0.8	0.8	1.0	1.0

$\bar{x}$: mean

Table III. Means and standard deviations for treatment time for the various malocclusion groups.

	Group 1			Group 2		
	$\bar{x}$ months	SD	N	$\bar{x}$ months	SD	N
Class I malocclusion	18.8	2.1	13	21.3	3.31	6
Class II Division I malocclusion	21.5	2.6	11	21.7	4.3	7
Class II Division 2 malocclusion	22.0	1.0	64	25.0	5.7	2
Class III malocclusion	19.5	4.1	4	21.7	3.0	7

$\bar{x}$: mean

* Miniature Twin, 3M Unitek, Monrovia CA, USA.

† Spectrum II, Ortho-care (UK) Ltd, Bradford, England.

Table IV. Means and standard deviations of treatment times for extraction and non-extraction cases.

	Group 1			Group 2		
	x months	SD	N	x months	SD	N
Extraction	20.5	2.2	26	22.6	4.5	25
Non-extraction	18.8	4.5	6	18.7	1.6	7

Table V. Archwire sequencing and mean duration of different types of archwires in patients treated using 0.018" slot brackets.

Archwire size and type	0.014 NT	0.016 NT	0.016 SS	0.016 x 0.022 NT	0.016 x 0.022 SS	0.017 x 0.025 NT	0.017 x 0.025 SS
Mean duration (Months)	2.7	2.7	3.8	2.8	3.3	2.4	2.5

NT: Nickel titanium, SS: Stainless steel.

Table VI. Archwire sequencing and mean duration of different types of archwires using 0.022" slot brackets .

Archwire size and type	0.014 NT	0.016 NT	0.018 NT	0.018 SS	0.020 SS	0.019 x 0.025 NT	0.019 x 0.025 SS
Mean duration Months	2.6	2.7	2.7	4.3	3.0	2.9	3.3

NT: Nickel titanium, SS: Stainless steel.

Results

The mean duration of orthodontic treatment for Group 1 patients was 20.2 months and for Group 2, 21.7 months (Table II). Treatment duration was shorter for those patients treated using the bracket with a 0.018" slot, the difference being statistically significant at $p < 0.05$.

The range of treatment duration for patients in Group 1 was between 13 and 25 months; notably lower than for patients in Group 2, which was between 16 and 29 months.

The mean number of appointments for patients in Group 1 was 18.9, with a range of between 15 and 25. The mean number of appointments for patients in Group 2 was 21.4, with a range of between 16 and 29 (Table II). The mean difference in the number of appointments between the two groups was statistically significant at $p < 0.05$.

When the duration of treatment times of the two groups in respect of malocclusion type was compared, it was found to be shorter for the Class I patients in Group 1 (18.9 months) than for the Class I patients in Group 2 (21.3 months) (Table III). This difference was statistically significant at $p < 0.05$, degrees of freedom (d.f.) = 27. In all other forms of malocclusion the duration of treatment times of the two groups was similar, although in respect of all malocclusion types, Group 1 patients had shorter treatment times. However, these differences were not statistically significant.

The mean duration of treatment for the non-extraction cases in both groups was virtually identical (18.8 months for Group 1 and 18.7 months for Group 2) (Table IV). The difference was not statistically significant.

The mean duration of treatment for the extraction cases was significantly different (20.5 months for Group 1 and 22.6 months for Group 2) (Table IV). The difference in the mean duration of treatment was statistically significant at $p < 0.05$, degree of freedom = 49.

Discussion

The results show that patients treated using a bracket with a 0.018" slot generally have shorter treatment times (1.5 months) than patients treated using a bracket with a 0.022" slot, using similar archwires. To our knowledge there have been no similar studies comparing treatment time with bracket slot size.

Almost all the initial patient variables for each group, such as the percentage of males and females, the number and type of extractions, the mean age at the start of treatment, the mean initial ANB, MP, overbite, and overjet were similar (Tables I and II). The only noticeable initial variation between the two was the initial Wits value, being Group 1: +0.5 mm and Group 2: -1.6 mm (Table II).

In comparing the results of this investigation with those of other workers, it is doubtful whether the study of Shelton *et al.*[1] can be listed because the Tip Edge technique allows limited tipping of teeth before uprighting with the Edgewise portion of the slot and, also, presumably, does not require the separate distalisation of cuspid teeth prior to the retraction of anterior teeth as standard Edgewise practice requires. The Vig[2] and Fink and Smith[3] studies do not mention archwire and slot sizes; however, their results are of interest and comparable in their overall treatment times. Also, their results included extraction cases and headgear-wearing cases, and comparisons must take these factors into consideration. Algerís[4] results, however, can be compared to the results of the Group 1 patients in the present study, as his patients were all treated using 0.018" slot brackets; however, in the present study 0.018" wires were not used in the bracket with the 0.018" slot. Alger found that his non-extraction group was treated in an average of 19.1 months (the range of treatment time is not clear); the present study had an average of 18.8 months, with a range of 13 to 25 months.

On the other hand, Cobb[5] recorded a one month shorter treatment time using 0.022" slot brackets than when using 0.018" slot brackets; this was probably because the same elastomeric ligatures were used to tie both single- and twin-wing brackets, generating the greater ligation forces for the twin-wing brackets. He found that both rotational correction of contact points and root paralleling occurred sooner. Further, he found that in both groups where twin-wing brackets were used in the upper arch, there was no difference in alignment times.

A study of Tables V and VI indicates that the stainless steel arches were fitted, on average, 1.1 months earlier in Group 1 patients than in Group 2 patients. This time period comprises 73 per cent of the overall difference in treatment times of the two groups. The remaining difference of 27 per cent could be due to the higher critical contact angle described by Kusy[6] that would occur in the 0.022" slot when 0.019" archwires are used, compared with the 0.017" wire in the 0.018" inch slot in the Group 1 patients. Further, the Group 1 patients were fitted with wider maxillary cuspid brackets than the Group 2 patients, further reducing the critical contact angle and thus reducing friction.

The mean duration of treatment for both groups in the present study was similar to those reported by several other investigators. Alger[4] reported a mean of 22.0 months, while Fink and Smith[3] reported a mean of 23.1 months. In the present study, the mean duration of treatment for Group 1 was 20.2 months and for Group 2, 21.7 months, the difference between the two groups being statistically significant at $p < 0.05$ support the hypothesis

The mean difference in treatment times between Groups 1 and 2 is more noticeable in respect of Class I malocclusion, at 2.5 months (Table III). However, firm conclusions cannot be made because of the small sample size in each group.

The mean difference in treatment times between Groups 1 and 2 in respect of extraction and non-extraction cases is very interesting. In the non-extraction cases, the mean treatment times are almost virtually identical (Table IV). In contrast, in the extraction cases, the mean difference between the two groups is significant (Table IV), the difference being statistically 2.1 months: d.f. = 49, $p < 0.05$. This suggests that space closure with sliding mechanics may be achieved more efficiently with a 0.018" slot bracket than with a 0.022" slot bracket; or it may be related to the wider canine bracket used with the 0.018" slot appliance. The wider the bracket, other things being equal, the easier it is to gain the activation of the archwire needed to bring roots together at extraction sites.[9]

The mean number of clinical adjustments for patients in Group 1 was significantly less (18.9 compared with 21.4 for Group 2) (Table II). This may be related to the earlier placement of a working wire (stainless steel) and to the decreased number of wire changes.

The wire size, type, sequence and the mean duration of use in Group 1 patients is presented in Table V. In this group, a stainless steel archwire was placed as early as 5.4 months into treatment, compared with 8.0 months in Group 2 patients (Table VI); consequently, intra-oral elastics were begun 2.6 months earlier in Group 1 patients because arch levelling was achieved earlier. The difference between archwire size and bracket slot size in Group 1 was less than that in Group 2 during

the early stages of treatment, thus, by closer engagement, making the archwires used in Group 1 more effective.

Friction may have influenced our results. The wider canine bracket used in Group 1 would have had the advantage of reducing the force on the wire as it slides through the bracket, thus decreasing friction from that source.[9] However, a wider bracket provides a larger area at the base of the bracket, thereby increasing the contact between the wire and the bracket. It is surprising that laboratory data indicate that bracket width has little effect on friction; however, it does have some effect.[10]

It would also have been interesting to see if the mean duration of treatment differed between the two groups had frictionless mechanics (closing loops) been used.

Conclusion

The mean duration of treatment for patients treated using the bracket with a 0.018" slot was statistically significantly different from the mean for those treated using the 0.022" slot bracket. This difference was more noticeable in both the Class I malocclusion groups and in the extraction groups. Although the mean difference in treatment time between the two groups was statistically significant, it may not be clinically significant. Further investigation of Class I malocclusions may enable firmer conclusions to be drawn about this particular group of patients. Future study of treatment times of similar cases treated with frictionless mechanics will illustrate the effect of archwire-size and slot-size geometry on standard Edgewise techniques.

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