Article:
Moesi, B., Dyer, F. and Benson, P.E. (2013) Roth versus MBT: does bracket prescription have an effect on the subjective outcome of pre-adjusted edgewise treatment? European Journal of Orthodonitics, 35 (2). 236 - 243. ISSN 0141-5387

https://doi.org/10.1093/ejo/cjr126

Roth v MBT: does bracket prescription have an effect on the subjective outcome of pre-adjusted edgewise treatment?

Bopelo Moesi [1]

Fiona Dyer [2]

Philip E Benson [1]

[1] Academic Unit of Oral Health and Development, School of Clinical Dentistry, University of Sheffield, UK

[2] Department of Orthodontics, Charles Clifford Dental Hospital, Sheffield, UK

Address for correspondence:

Dr Philip Benson

Reader in Orthodontics

Academic Unit of Oral Health and Development

School of Clinical Dentistry

Sheffield

S10 2TA

Tel 44 1142717885

Fax 44 1142717843

e-mail: p.benson@sheffield.ac.uk

Short running title: Roth v MBT: subjective outcomes.

Abstract

The aim was to determine if bracket prescription has any effect on the subjective outcome of pre-adjusted edgewise treatment as judged by professionals. This retrospective, observational assessment study was undertaken in the Orthodontic Department of the Charles Clifford Dental Hospital, Sheffield, UK. Forty sets of post-treatment study models from patients treated using a pre-adjusted edgewise appliance (20 Roth, 20 MBT) were selected. The models were masked and shown in a random order to 9 experienced orthodontic clinicians, who were asked to assess the quality of the outcome, using a pre-piloted questionnaire. The principal outcome measure was the Incisor and Canine Aesthetic Torque and Tip (ICATT) score for each of the 40 post-treatment models carried out by the nine judges. A two-way ANOVA was undertaken with the dependent variable, total ICATT score and independent variables, Bracket prescription (Roth or MBT) and Assessor. There were statistically significant differences between the subjective assessments of the nine judges ($P<0.001$), but there was no statistically significant difference between the two bracket prescriptions ($P=0.900$). The best agreement between a clinician's judgment of prescription used and the actual prescription was fair (kappa statistic 0.25; CI -0.05-0.55). The ability to determine which bracket prescription was used was no better than chance for the majority of clinicians. Bracket prescription had no effect on the subjective aesthetic judgments of post-treatment study models made by nine experienced orthodontists.

Introduction

Since the introduction of the Straight Wire Appliance™ in the 1970s (Andrews 1979) there have been many suggested modifications to the tip and torque values used in pre-adjusted edgewise appliances. Many of these changes involve alterations of a few degrees, even though it is known that torque expression in particular, is affected by the amount of play between the archwire and the slot (Archambault*, et al.* 2010), differences in the tolerance size of manufactured brackets and archwires (Cash*, et al.* 2004), the method of ligation (Badawi*, et al.* 2008, Gioka and Eliades 2004), the initial inclination of the teeth (Archambault*, et al.* 2010), additional widening and notching of the bracket slot when placing the larger archwires (Archambault*, et al.* 2010) and even variations in the shape of the labial surface of teeth (Smith*, et al.* 2007).

The MBT prescription was introduced in 1997 and quickly established itself as one of the most popular bracket prescriptions on the market. The main differences with other bracket prescriptions are:

- Increased palatal root torque in the upper central incisor brackets (Andrews: 7°; Roth: 12°; MBT: 17°)
- Increased palatal root torque in the upper lateral incisor brackets (Andrews: 3°; Roth: 8°; MBT: 10°)
- Increased lingual crown torque in the lower incisor brackets (Andrews: -1; Roth: -1°; MBT: -6°)
- Decreased tip in the upper canine brackets (Andrews: 11°; Roth: 13°; MBT: 8°).

The developers of the appliance claim that the increased palatal root torque in the upper incisors improves the under-torqued appearance produced by other prescriptions and the increased labial root torque in the lower incisor counteracts the forward tipping during levelling(Mclaughlin*, et al.* 2001). To-date there have been no scientific studies to support these claims.

Several studies have shown the variations in torque values of teeth achieved following treatment with pre-adjusted edgewise appliances (Dellinger 1978, Ugur and Yukay 1997, Vardimon and Lambertz 1986). Kattner and Schneider (1993) found no differences in the Ideal Tooth Relationship Index when they compared the study models of patients treated using a Roth prescription pre-adjusted edgewise appliance with those treated using a standard edgewise appliances. Ugar and

Yukay (1997) found no differences in the objectively measured torque values between cases treated using standard edgewise and a pre-adjusted Roth prescription appliance.

The aim of this study was to investigate the bracket manufacturers' claims that when a patient is treated to a reasonable occlusal outcome then small changes in bracket prescription can lead to visually detectable differences in tooth positions.
The specific research questions were:

From a sample of study models taken from patients with skeletal 1 malocclusions, treated with either upper or upper and lower premolar extractions to a good occlusal result:

- Is there a difference in the subjective aesthetic judgments of orthodontists in the appearances of maxillary and mandibular incisor torque, or maxillary canine torque and tip between the Roth and MBT prescription?

- Are orthodontists able to distinguish if a patient was treated with the Roth or MBT prescription?

The null hypotheses were that there are no differences in the subjective aesthetic judgments of orthodontists as to the appearance of torque of the maxillary and mandibular incisors and the tip of the maxillary canines between cases treated using a pre-adjusted edgewise appliance with a Roth or MBT prescription.

Subjects and Methods

The sample consisted of the post-treatment study models of 40 patients treated in the Orthodontic Department of XXXXXXXXX. This was a convenience sample, chosen retrospectively, to be representative of a common type of orthodontic patient, treated to a good occlusal result, in a UK postgraduate teaching hospital. Twenty patients had received a pre-adjusted edgewise appliance with the Roth prescription (Ovation, DENTSPLY GAC, Bohemia, NY, USA) and 20 patients had received the MBT prescription (Victory, 3M, St. Paul, MN, USA). Confirmation of the bracket prescription used was obtained from the hospital notes, the departmental database and by examination of clinical photographs taken during treatment. The patients were treated by several

operators, but archwires were standardised within the department (Sentalloy nickel-titanium aligning archwires, DENTSPLY GAC, Bohemia, NY, USA and 0.019 x 0.025-inch ss working archwires, DB Orthodontics, Silsden, West Yorks, UK).

An *a priori* sample size estimation could not be performed as there were no data upon which to base the calculation; however a *post hoc* power analysis was undertaken once data had been collected, to determine what a suitable sample size to detect a significant difference might be, based on the results of this study

The following inclusion criteria were applied for the selection of the patient records:

- Aged 20 years or under;
- Two premolar extractions in the upper arch or four upper and lower premolar extractions;
- A PAR score of 5 or less from the post-treatment study models;
- Placement of a 0.019 x 0.025-inch stainless steel working archwire for at least one visit;
- An ANB angle not less than 1° and not more than 5°

Patient records were excluded if they were treated with:

- A non-extraction approach;
- Extractions other than premolars;
- A functional appliance;
- Headgear;
- Orthognathic surgery

The pre-treatment records were examined by two experienced specialist orthodontists to determine the incisor relationship, the size of the overjet and the degree of upper and lower arch crowding. Any disagreements were resolved by a third experienced orthodontist. The examiners were unaware of which bracket prescription had been used. Data about the demographics of the patient and length of treatment were obtained from the clinical records.

The 40 sets of models were duplicated and cast in the same yellow stone by one investigator to ensure uniformity of appearance. They were then allocated a computer-generated random number from 1 to 40.

A questionnaire to capture a clinician's subjective assessments of the incisor torque and canine tip of each model was developed through discussions with experienced orthodontic clinicians. It was piloted by two senior specialist registrars and modified. The final questionnaire (Appendix 1) consisted of two questions concerning upper and lower incisor torque, two questions about the torque in the right and left upper canine and two questions about the right and left upper canine tip. A seventh question asked the respondent to state whether they thought that the case had been treated using an MBT or a Roth prescription. Photographs showing distal, upright and correct maxillary canine tip configurations were provided to each clinician as an aid in the determination (Appendix 1). The responses for the first six questions were on a 5-point Likert scale (Appendix 1). The response for question 7 was a dichotomous (MBT or Roth).

The questionnaire was administered to nine orthodontic clinicians (4 consultants, 2 senior postgraduate trainees and 3 other specialists). Each assessor was masked as to the identity of the original patient, the prescription used and the number of models of each prescription.

To test reproducibility the models were re-numbered from 1 to 40 in a new random order and three assessors reassessed the whole sample at least three weeks after the initial assessment.

Statistical analysis

Data were entered into an Excel® spreadsheet (Microsoft 2007) and PASW Statistics (SPSS Inc v 18) was used to undertake the statistical tests. Agreement between examiners for the pre-treatment characteristics was determined using an unweighted kappa statistic.

Differences in the aesthetic outcomes for the two bracket prescriptions were examined using a total Incisor and Canine Aesthetic Torque and Tip score. The responses to Questions 1 to 6 were given a score ranging from 0 (All 4 teeth inadequately torqued; Severely undertorqued; Significant distal tip) to 4 (All 4 teeth adequately torqued; Best possible torque; Correct tip). The scores for the six questions were summed to produce a total score for each model (minimum score 0, maximum score 24).

The reproducibility of the repeat ICATT scores was assessed using an intra-correlation coefficient for random error and a paired *t* test for systematic error. The agreement between the first and second assessments of whether the assessor considered the case to have been treated using MBT or Roth (question 7) was analysed using an unweighted kappa statistic.

The null hypothesis was that there was no difference in the scores for the two prescriptions; however the assessor was also included in the analysis as an independent variable to take into account inter-examiner differences. The distribution of the data was examined and found to be normally distributed, but truncated. This was because the peak of the distribution was towards the higher scores, however as it was impossible to achieve a score larger than 24, although the curve was diminishing it did not return to the horizontal axis. Several ways of transforming the data were attempted, but no suitable method was found and we were unable to determine a non-parametric equivalent of the two-way ANOVA, which allowed an analysis of two independent variables (assessor and bracket). Following statistical advice it was decided that since the data were truncated-normal then a two-way ANOVA was acceptable; however to confirm this a non-parametric Mann-Whitney U test was conducted to analyse the difference in ICATT scores for each of the assessors to examine if this agreed with the results of the overall ANOVA. The dependent variable for the two-way ANOVA was the total ICATT score and the independent variables were bracket prescription (Roth or MBT) and Assessor.

The mean values of all nine assessors' judgments for the six characteristics and the Total ICATT scores were calculated and a Mann-Whitney U test carried out to determine any differences. As multiple comparisons were undertaken the significance level was set at $p<0.01$.

For question 7, the agreement between the assessor's judgment about which prescription was used and the actual prescription used was assessed using the kappa statistic. The strength of the agreement was determined using the criteria suggested by Landis and Koch (Landis and Koch 1977).

Results

The kappa scores for agreement between examiners for the pre-treatment occlusal characteristics were either substantial (Incisor Relationship 0.80, 95% CI 0.65 to 0.95; Lower Arch Crowding 0.78, 95% CI 0.60 to 0.96) or almost perfect (Upper Arch Crowding 0.81, 95% CI 0.65 to 0.97). Table 1 shows the pre-treatment patient and occlusal characteristics, length of time and number of appointments in active orthodontic treatment for the two bracket prescription groups. There was a slightly higher number of patients with a class I incisor relationship in the Roth prescription group and a slightly higher number of patients with moderate lower arch crowding in the MBT group, but otherwise the pre-treatment patient, occlusal and treatment characteristics were very similar.

The 40 post-treatment study models were assessed by six specialist orthodontists on one occasion and by three specialist orthodontists on two occasions making a total of 480 separate assessments. The results of the reproducibility assessment are shown in Table 2. Assessor 1 had the largest mean difference between the two ICATT readings (-1.1), which was statistically significant (P=0.035) suggesting a systematic error. The random error showed moderate agreement. The other two assessors had lower mean differences in their repeat ICATT scores, with no systematic error and substantial agreement for random error.

The levels of agreement for the three assessors repeat assessments of whether the case was treated with Roth or MBT prescription are shown in Table 3. Assessor 2 showed the best agreement between the first and second viewings, but this was only moderate (kappa=0.52) and the 95% confidence intervals were wide (lower limit kappa=0.20; slight agreement to upper limit kappa=0.84; almost perfect agreement).

Table 4 shows the results of the two-way analysis of variance. There were significant differences between the individual assessors' scores (P<0.001); however the scores for the two bracket systems were not significantly different (P=0.900). This was confirmed by the Mann-Whitney U tests for the individual judges, none of which showed a significant difference between the two brackets systems (P values ranged from 0.120 for Assessor 5 to 0.978 for Assessor 1). Since the overall ANOVA showed no effect for bracket and this agrees with the nine individual assessors' Mann-Whitney U tests, then it can be concluded that bracket prescription had no significant effect on the aesthetic scores.

Table 5 shows the descriptive data for the mean aesthetic scores provided by the nine assessors for the 20 cases treated using MBT prescription and 20 cases treated using Roth prescription. There were no statistically significant differences between the judgments made for the two prescriptions for any of the six attributes or total ICATT scores.

Examination of the individual scores showed that generally the majority of the assessors agreed on the outcomes of good and bad cases; however there were wide discrepancies in the subjective assessments of some cases. For example, case 4 received a Total ICATT score of 2 from Assessor 9 and a score of 20 from Assessor 7. For other cases there was reasonable consensus e.g. case 38 had a minimum score of 18 from Assessor 4, a maximum score of 24 from Assessor 6 and six assessors gave it the same Total ICATT score of 22. To determine if there were any differences between the cases they were arranged according to their average total score per case (Figure 1). No case obtained a mean maximum score (24). The best case was treated with the Roth prescription and the worst case with the MBT prescription. However, from the best 25 percent of cases (top 10 cases), 6 were treated with MBT and 4 with Roth. From the worst 25 percent of cases (bottom 10 cases) 5 were treated with each prescription. Most of the cases (80%) had scores between 14 and 20. To determine if the poorly ranked cases skewed the data the comparison was repeated with the 10 poorly ranked cases of each prescription excluded; however there were still no statistically significant differences between the two prescriptions for any of the variables (Total ICATT Mann-Whitney U test P=0.845).

The assessors were asked to predict whether the cases were treated with MBT or Roth prescriptions. Table 5 shows the agreement between the assessments of the nine assessors about which prescription they thought had been used and the actual prescription used. The best kappa statistic achieved for assessor validity was a fair agreement (0.25); however the confidence interval ranged from poor agreement (-0.05) to moderate agreement (0.55). Six assessors achieved slight agreement whereas two assessors achieved poor agreement. The agreement between assessor judgment and the actual prescription used for treating each case was not statistically significant for any of the assessors.

To determine if the length of time the patient had a rectangular stainless steel archwire in place affected the subjective outcome we examined a scatterplot of the time the patient was in the

0.019 x 0.025-inch stainless steel archwire, as determined from the clinical record, against the mean Total ICATT scores from the nine examiners for all 40 cases. The Pearson's product correlation coefficient was also calculated. There was no obvious visual relationship between the two from the scatterplot (Figure 2) and the correlation coefficient was both weak (r = 0.106) and non-significant.

Discussion

This study found no differences in the subjective assessments carried out by experienced orthodontic clinicians of the post-treatment study models from patients who had been treated with premolar extractions and pre-adjusted edgewise fixed appliances using a Roth prescription compared with a MBT prescription. In fact the clinicians' determination of which prescription had been used was, in most individuals, no better than chance. It therefore appears that for treating skeletal Class I cases, with at least 2 premolars extracted, it does not matter whether one treats a case with the MBT or Roth prescription, as the subjective outcome is the same. This study did not examine the issue of stability, which can only be determined with long term follow up of patients.

The study models were a convenience sample chosen retrospectively. This could lead to potential bias; however specific inclusion criteria were used to produce representative samples of skeletal 1 orthodontic cases treated with upper or upper and lower premolar extractions to a good standard in a postgraduate teaching clinic. A recognised quality outcome (post-treatment PAR score of 5 or less) was one inclusion criterion, as the objective was not to determine whether the MBT or Roth prescriptions were more effective at producing a good occlusal result; a prospective, randomised design would be an appropriate study design to the answer that question; but to assess if differences between the prescription could be detected by experienced clinicians once a good occlusal result had been achieved. The use of these relatively strict criteria, particularly the outcome measure, would make it very difficult to obtain a sample of consecutively started patients, as many cases would be excluded. The details of the patient demographics, malocclusion and treatment characteristics show that the two patient samples were very similar and all the models were masked to avoid assessment bias.

The method of assessing the outcome of treatment used in this study was developed to be clinically relevant, quick and easily applied to the teeth that are potentially most affected by the

changes in the prescription values. Investigators who have used more objective methods of measurement have also been unable to find significant differences between appliances (Ugur and Yukay 1997). It might be true that more contemporary objective and precise methods of measurements, such as 3D laser scanning, may be able to detect differences between appliances, nevertheless we would argue that for a specialty, which is aiming to produce the best aesthetic result, a difference that is not detectable by the human eye is of little importance.

Kattner and Schneider (1993) examined the post-treatment study models of 120 patients treated using a standard edgewise appliance and pre-adjusted edgewise Roth prescription appliance by two specialist orthodontists. The investigators did not find any significant differences in the outcomes between appliance systems; however they did find differences between the two clinicians. The clinician judged to have better occlusal outcomes routinely took longer to finish cases and more often used a full sized archwire than the practitioner with the lower scores. We found no difference in the length of active treatment between patients treated with the MBT and Roth prescriptions and we also examined our sample to see if the length of time in the largest archwire used in our cases (0.019 x 0.025-inch stainless steel) influenced the outcome, but were unable to find any relationship. The average length of time the patients in our sample were in a 0.019 x 0.025-inch ss archwire was 11 months. The case that scored the highest mean Total ICATT score was in this archwire for 13 months; however 10 from the best 20 cases used the 0.019 x 0.025-inch ss archwire for less than 11 months.

It is possible that it is not the length of time in the largest archwire used, but the size of archwire that affects the outcome. Finishing cases in wires that do not substantially fill the bracket slot will not fully express the torque values. The cases in this study were finished with 0.019 x 0.025-inch ss archwires in a 0.022 x 0.028-inch bracket slots. Ugur and Yukay (1997) examined cases finished with 0.016 x 0.022-inch ss archwires in a 0.018 x 0.030-inch bracket slots. The loss of torque of a 0.016 x 0.022-inch archwire in a 0.018-inch bracket slot is approximately 14°, which is similar to that of a 0.019 x 0.025-inch archwire in a 0.022-inch bracket slot (Badawi*, et al.* 2008, Gioka and Eliades 2004, Sebanc*, et al.* 1984). Increasing the archwire size to dimensions 0.017 x 0.025-inch in a 0.018-inch bracket slot decreases the play to 6°, but this is the same magnitude as the difference between the torque values of the Roth and MBT prescriptions. Kattner and Schneider (1993) did not find any differences between cases finished using 0.017 x 0.025-inch ss archwires compared with cases finished using 0.016 x 0.022-inch ss archwires. It is possible that if the patients were

treated with full sized 0.021 x 0.028-inch ss archwires, which have a greater potential for full torque expression, then differences between bracket prescriptions might be detected; however the routine use of full size archwires is not advocated by those who developed the MBT appliance (Mclaughlin*, et al.* 2001).

It has been shown that there are differences in the tolerance size of manufactured brackets and archwires (Cash*, et al.* 2004). The archwires used in the patient sample were from the same supplier; but the brackets were made by different manufacturers and one may have been manufactured to a better tolerance than the other. However, if small changes to bracket prescription make a difference to tooth position then one might expect that the bracket with the lower tolerance would produce a better aesthetic outcome, which experienced clinicians would be able to detect, but they could not. Other reasons for the finding that bracket prescription made no difference to the subjective assessments of treatment outcome might include the possibility that clinicians manipulated the working archwire to introduce more torque into the cases treated with the Roth prescription; but very few clinicians stated in the patient record that this had been carried out. Another reason for the lack of difference might be due to inaccuracies in bracket placement, leading to inaccuracies in tip and torque expression. Some assessors made comments to this effect about some of the cases.

It is possible that tip is more fully expressed in a pre-adjusted edgewise appliance than torque. There is a 5° difference in canine tip between the MBT and Roth prescriptions and the expectation was that the patients treated using the MBT prescription would have more upright upper canine teeth compared with the more mesially tipped canines of patients treated using the Roth prescription. The results of this study suggest that the two appliance prescriptions could not be differentiated on the basis of canine tip.

The questionnaire was piloted before starting the investigation to test the relevance and ease of use; however the design of study could be criticized for a number of reasons. Firstly we used experienced clinicians to make a judgment from study models, whereas it might be more appropriate to ask lay people, patients or parents to assess the smile aesthetics. Studies have suggested that lay people assess the smile differently to clinicians (Flores-Mir*, et al.* 2004); however orthodontists tend to be more critical than lay people or even general dentists (Kokich*, et*

al. 2006) so using non-specialists would potentially make it even less likely that a significant difference could be found.

Another criticism of this investigation is that no calculation to determine a suitable sample size needed to detect a clinically significant difference if one truly exists was performed before carrying out the study. This was not undertaken, because there were no data upon which to base the calculation. It is however, possible to use the actual data from the study to determine how many patients would be required to show a significant difference. The largest difference in the subjective judgments between the two bracket systems was for the torque in the upper right canine. The mean difference between the scores for the patients treated using Roth prescription and those treated using the MBT prescription was 0.07 (SD 0.60). This gives a standardized difference of 0.12 (Altman 1991). Using the nomogram for continuous data (two independent groups) and assuming that this was a representative sample we would require approximately 3000 patients to detect a significant difference between the two bracket systems for this assessment alone and probably many more for the other assessments. Even if we were able to use an objective measurement of tooth angulations, instead of a subjective assessment, previous studies suggest that the variation in the measurements (Dellinger 1978, Vardimon and Lambertz 1986) would be such that sample sizes into the thousands would be required in order to find significant differences and then these might not be detectable to the human eye.

A further potential criticism of the study is that the patients were treated by different clinicians, albeit from one centre. Operator variability might therefore have masked any differences in bracket prescription. We would argue that an original objective of the pre-adjusted edgewise appliance was to reduce the amount of wire bending required when treating patients and therefore promote more consistent treatment outcomes both within and between individual operators. Using the study models from patients treated by different operators is more representative of what happens in the real world, but examining study models from single operators might be the basis for further investigations. Another potential weakness is that each assessor was asked to carry out 280 judgments and that fatigue might have affected the results. No time restraints were placed on the assessor to carry out the work and they were advised to take regular breaks throughout the assessment period.

As previously stated we used reasonably strict and limited inclusion and exclusion criteria in the selection of models for this investigation. Further work involving patients with skeletal 2 and skeletal 3 malocclusions, as well as those treated non-extraction is required to confirm that small changes in pre-adjusted edgewise bracket prescriptions has no effect on the aesthetic judgments of the final results of orthodontic treatment. When one considers the many factors that affect torque expression, not least of which is the amount of variation in the torsional or engagement angle between the bracket slot and the wire (Archambault*, et al.* 2010), then it is perhaps not surprising that small changes in pre-adjusted edgewise bracket prescriptions fail to make any clinically detectable differences to the subjective appearance of the final result.

In conclusion this study has found that bracket prescription had no effect on the subjective aesthetic judgments made by nine experienced orthodontists from the post-treatment study models of patients treated with premolar extractions and a pre-adjusted edgewise fixed appliance system using either a Roth or MBT prescription. In the majority of cases the ability of the clinicians to determine which bracket prescription was used was no better than chance in the majority of cases.

Acknowledgements

The authors would like to thank the nine orthodontists who took part in this study, as well as as Dr Kathleen Baster of the Statistical Services Unit, University of Sheffield for help with the statistical analysis and Dr Nicola Parkin for resolving disagreements between PEB and FD on the pretreatment characteristics.

References

Altman D G 1991 Practical Statistics for Medical Research. Chapman & Hall, London

Andrews L F 1979 The straight-wire appliance. British Journal of Orthodontics 6:125-143

Archambault A, Lacoursiere R, Badawi H, Major P W, Carey J, Flores-Mir C 2010 Torque expression in stainless steel orthodontic brackets. A systematic review. Angle Orthodontist 80:201-210

Badawi H M, Toogood R W, Carey J P, Heo G, Major P W 2008 Torque expression of self-ligating brackets. American Journal of Orthodontics and Dentofacial Orthopedics 133:721-728

Cash A C, Good S A, Curtis R V, McDonald F 2004 An evaluation of slot size in orthodontic brackets--are standards as expected? Angle Orthodontist 74:450-453

Dellinger E L 1978 A scientific assessment of the straight-wire appliance. American Journal of Orthodontics 73:290-299

Flores-Mir C, Silva E, Barriga M I, Lagravere M O, Major P W 2004 Lay person's perception of smile aesthetics in dental and facial views. Journal of Orthodontics 31:204-209

Gioka C, Eliades T 2004 Materials-induced variation in the torque expression of preadjusted appliances. American Journal of Orthodontics and Dentofacial Orthopedics 125:323-328

Kattner P F, Schneider B J 1993 Comparison of Roth appliance and standard edgewise appliance treatment results. American Journal of Orthodontics and Dentofacial Orthopedics 103:24-32

Kokich V O, Kokich V G, Kiyak H A 2006 Perceptions of dental professionals and laypersons to altered dental esthetics: asymmetric and symmetric situations. American Journal of Orthodontics and Dentofacial Orthopedics 130:141-151

Landis J R, Koch G G 1977 The measurement of observer agreement for categorical data. Biometrics 33:159-174.

McLaughlin R P, Bennett J C, Trevisi H 2001 Systemized orthodontic treatment mechanics Mosby, London

Sebanc J, Brantley W A, Pincsak J J, Conover J P 1984 Variability of effective root torque as a function of edge bevel on orthodontic arch wires. American Journal of Orthodontics 86:43-51

Smith R N, Karmo M, Russell J, Brook A H 2007 The variability of the curvature of the labial surface of the upper anterior teeth along the facial axis of the clinical crown. Archives of Oral Biology 52:1037-1042

Ugur T, Yukay F 1997 Normal faciolingual inclinations of tooth crowns compared with treatment groups of standard and pretorqued brackets. American Journal of Orthodontics and Dentofacial Orthopedics 112:50-57

Vardimon A D, Lambertz W 1986 Statistical evaluation of torque angles in reference to straight-wire appliance (SWA) theories. American Journal of Orthodontics 89:56-66

Figures

Figure 1

Graph showing the frequency of mean total ICATT scores (min 0; max 24) from the nine judges for the cases treated with either the Roth (n = 20) or MBT prescriptions (N=20)

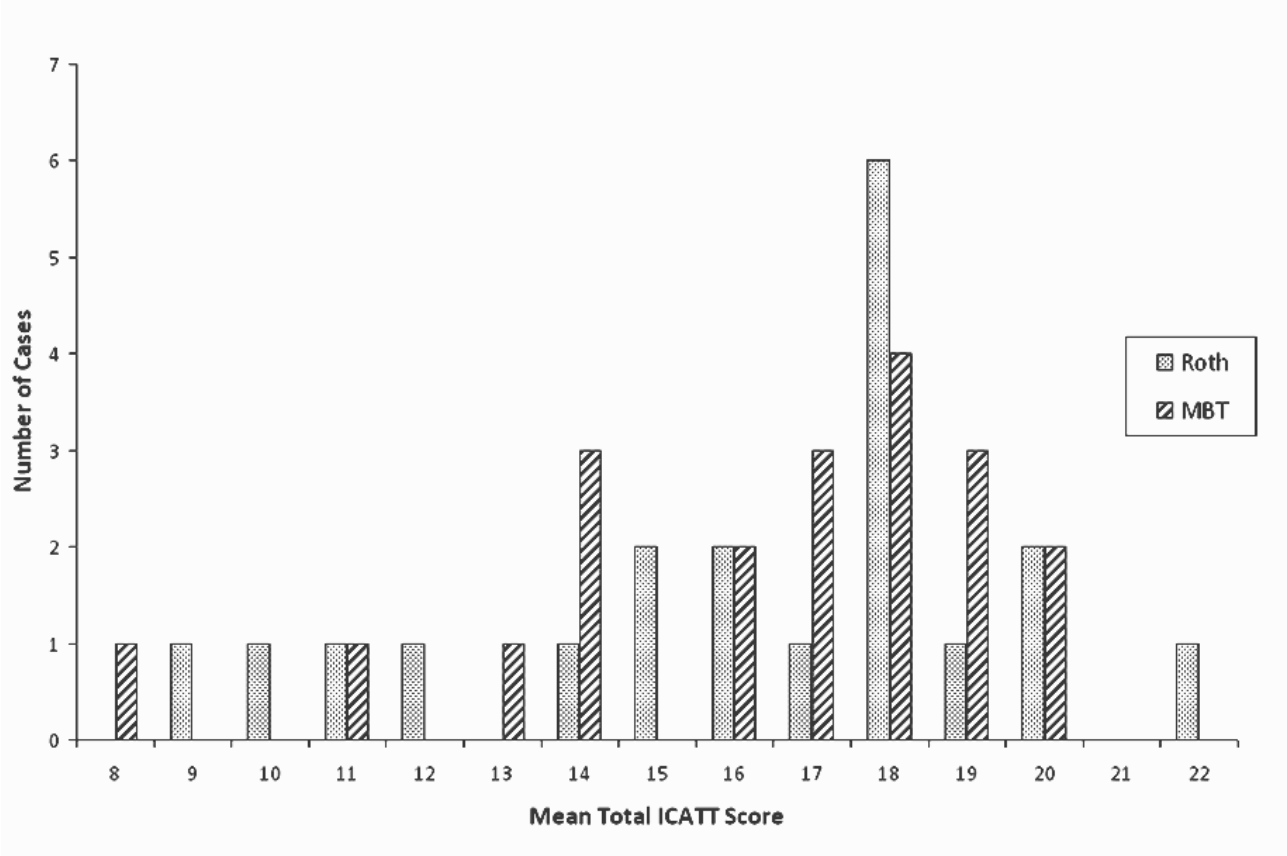
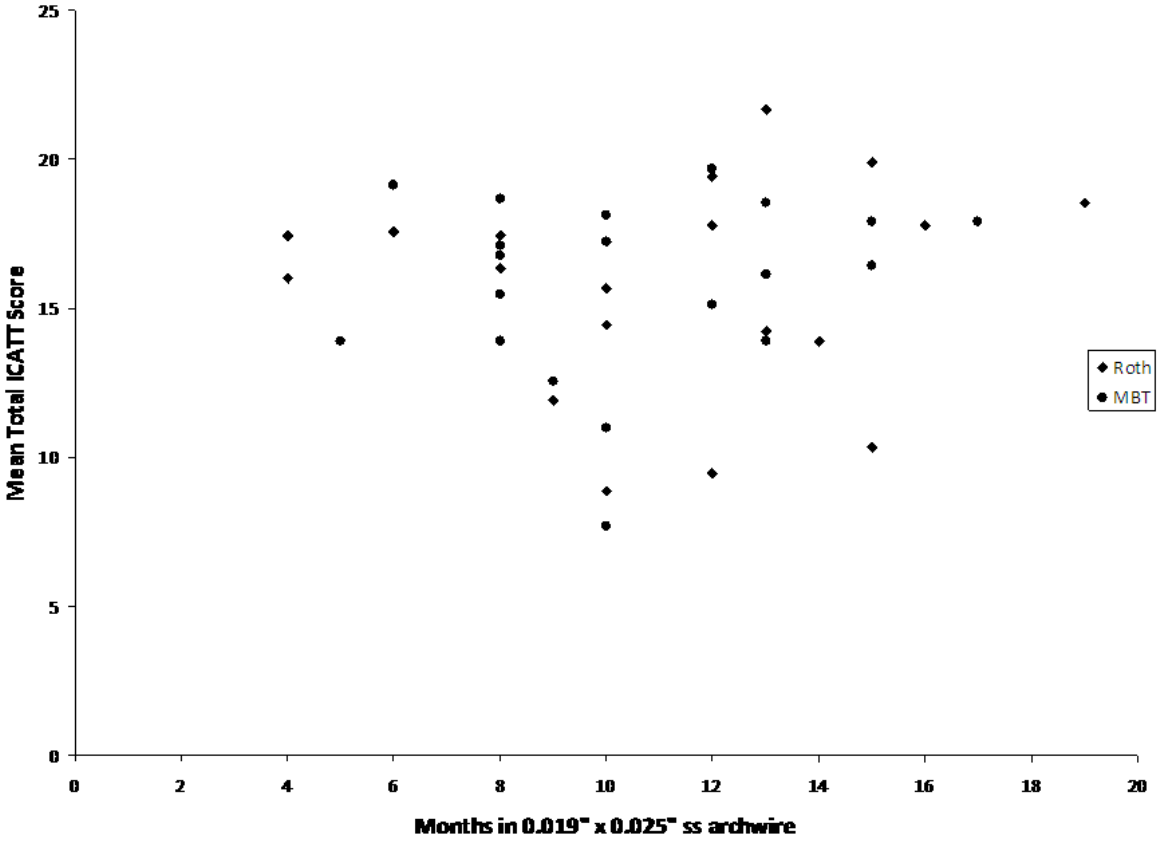


Figure 2

Scatterplot of time in 0.019 x 0.025-inch stainless steel archwire against mean Total ICATT scores from the nine judges



Tables

Table 1

Pre-treatment patient and occlusal characteristics, length of time and number of appointments in active orthodontic treatment.

		MBT (N=20)	Roth (N=20)
Incisor Relationship	Class I	3	8
	Class II divisions 1	8	7
	Class II div 2	4	3
	Class II Intermediate	2	0
	Class III	3	2
Overjet (mm)	Mean (sd)	4.0 (1.7)	3.7 (2.3)
Upper Arch Alignment	No or mild crowding (0-4mm)	9	10
	Moderate crowding (5-8mm)	7	6
	Severe crowding (>9mm)	4	4
Lower Arch Alignment	No or mild crowding (0-4mm)	10	15
	Moderate crowding (5-8mm)	9	5
	Severe crowding (>9mm)	1	0
Age at start of treatment (yrs)	Mean (sd)	15.1 (1.8)	14.4 (2.7)
Length of treatment (mths)	Mean (sd)	24.4 (8.1)	23.3 (6.3)
Nos of appts in appliances	Mean (sd)	17.1 (3.7)	16.0 (3.8)

Table 2

Reproducibility of 3 judges repeat ICATT scores including mean difference, standard deviation of the differences, 95% confidence intervals, p-value of paired *t* test for systematic error and intra-class correlation coefficient for random error.

Judge	Mean difference	SD of differences	95% CI		P-Value	ICC
			Lower	Upper		
1	-1.1	3.1	-2.0	-0.1	0.035	0.53
2	0.4	2.5	-0.4	1.2	0.314	0.71
7	-0.4	3.3	-1.4	0.7	0.470	0.63

Table 3

Agreement of 3 judges repeat assessments of whether the case was treated with Roth or MBT prescription including kappa statistic, 95% confidence intervals and strength of agreement according to the criteria of Landis and Koch (1977).

Judge	Kappa statistic	95% CI		Strength of Agreement
		Lower	Upper	
1	0.04	-0.27	0.34	Slight
2	0.52	0.20	0.84	Moderate
7	0.34	0.03	0.65	Fair

Table 4

Results of two way analysis of variance with dependent variable Total ICATT score and two independent variables of bracket and assessor.

Source	Type III Sum of Squares	df	Mean Square	F	P
Corrected Model	1181.250*	9	131.3	7.4	<0.001
Intercept	90123.4	1	90123.4	5114.5	<0.001
Bracket	0.3	1	0.3	0.0	0.900
Assessor	1181.0	8	147.6	8.4	<0.001
Error	6167.4	350	17.6		
Total	97472.0	360			
Corrected Total	7348.6	359			

*R Squared = 0.161 (Adjusted R Squared = 0.139)

Table 5

Descriptive statistics for the six attributes and total ICATT scores for the 20 cases treated using Roth prescription and 20 cases treated using MBT prescription including means, standard deviations, 95% confidence intervals, ranges and p-values (Mann-Whitney U test).

Attribute	Prescription	Mean Score	SD	95% confidence interval		Min	Max	P-value
				Lower	Upper			
Upper incisor torque	Roth	2.6	1.2	2.0	3.1	1	4	0.828
(score 0-4)	MBT	2.7	1.3	2.0	3.3	0	4	
Lower incisor torque	Roth	3.2	1.3	2.5	3.8	0	4	0.773
(score 0-4)	MBT	3.4	0.8	3.0	3.8	1	4	
Upper right canine torque	Roth	2.3	0.6	2.0	2.5	1	3	0.587
(score 0-4)	MBT	2.2	0.5	2.0	2.4	1	3	
Upper left canine torque	Roth	2.4	0.6	2.1	2.6	1	3	0.430
(score 0-4)	MBT	2.4	0.7	2.1	2.7	1	3	
Upper right canine tip	Roth	2.7	1.1	2.2	3.2	0	4	0.725
(score 0-4)	MBT	2.6	1.0	2.2	3.1	0	4	
Upper left canine tip	Roth	2.9	1.2	2.3	3.4	0	4	0.490
(score 0-4)	MBT	2.5	1.0	2.1	2.9	1	4	
Total ICATT score	**Roth**	**15.9**	**3.0**	**14.5**	**17.2**	**8**	**20**	**0.957**
(score 0-24)	**MBT**	**15.8**	**3.5**	**14.3**	**17.3**	**9**	**22**	

Table 6

The individual agreements for the 9 judges as to whether the case was treated with Roth or MBT prescription with the actual bracket prescriptions used including kappa statistic, 95% confidence intervals and strength of agreement according to the criteria of Landis and Koch (1977).

Judge	Kappa statistic	95% CI		Strength of Agreement
		Lower	Upper	
1	-0.05	-0.37	0.27	Poor
2	0.20	-0.07	0.47	Slight
3	0	-0.31	0.31	Slight
4	0.25	-0.05	0.55	Fair
5	0.10	-0.19	0.39	Slight
6	0	-0.32	0.32	Slight
7	-0.05	-0.36	0.26	Poor
8	0.10	-0.21	0.41	Slight
9	0.05	-0.26	0.36	Slight

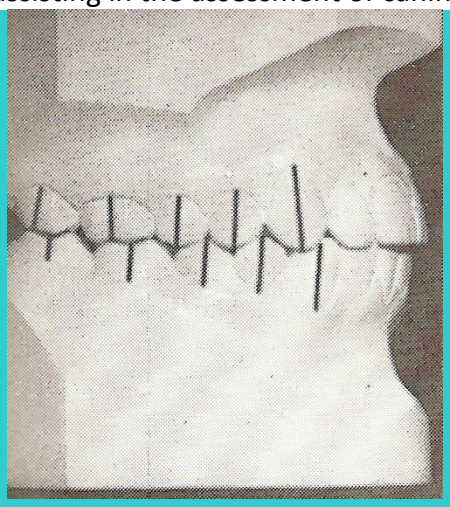
Appendix 1

Does bracket prescription have an effect on the outcome of fixed orthodontic treatment?

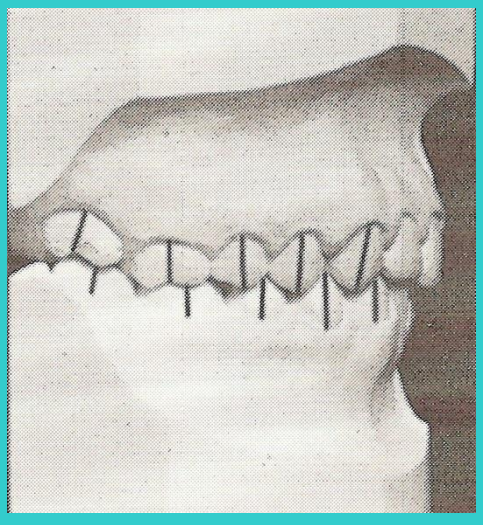
By assessing the torque of the upper and lower incisors (labio-lingual/palatal) and both the torque and tip (mesio-distal) of the upper canines, we wonder whether you are able to predict if a case was treated using the MBT or Roth prescription better than chance.

You are asked to assess 6 aspects of each finished case and then to predict if it was treated with Roth or MBT bracket prescriptions.

The following visual scale is for assisting in the assessment of canine mesio-distal tip:



Correct Tip



Distal Tip

Upright

Please assess the following 40 cases.

Case Number: .....

Incisor torque

1. Torque of the upper incisors **(UR2 to UL2)**

All 4 teeth inadequately torqued	3 teeth inadequately torqued	2 teeth inadequately torqued	1 tooth inadequately torqued	All 4 teeth adequately torqued

2. Torque of the lower incisors **(LR2 to LL2)**

All 4 teeth inadequately torqued	3 teeth inadequately torqued	2 teeth inadequately torqued	1 tooth inadequately torqued	All 4 teeth adequately torqued

.....

Upper canine torque

3. Torque of upper right canine **(UR3)**

Severely under-torqued	Poor torque	Satisfactory torque	Good torque	Best possible torque

4. Torque of upper left canine **(UL3)**

Severely under-torqued	Poor torque	Satisfactory torque	Good torque	Best possible torque

.....

Upper canine mesio-distal tip

5. Mesio-distal tip of upper right canine **(UR3)**

Significant distal tip	Mild distal tip	Upright	Significant mesial tip	Correct tip

6. Mesio-distal tip of upper left canine **(UL3)**

Significant distal tip	Mild distal tip	Upright	Significant mesial tip	Correct tip

.....

7. **Do you think this case was treated with MBT or Roth?**

MBT		**Roth**	

Thank you!!