

Factors Affecting the Outcome of Orthodontic Treatment within the General Dental Service

N. A. FOX, B.CH.D., F.D.S., R.C.P.S.(GLAS), M.SC., M.ORTH R.C.S. (ENG)

Orthodontic Department, Middlesbrough General Hospital, Ayresome Green Lane, Middlesbrough, Cleveland TS5 5AZ, U.K.

S. RICHMOND, B.D.S. F.D.S., R.C.S. (EDIN), D.ORTH., R.C.S., M.SC.D., PHD.

Department of Child Dental Health, University Dental Hospital, University of Wales College of Medicine, Heath Park, Cardiff CF4 4XY, U.K.

J. L. WRIGHT, B.SC.

Department of Oral Health and Development, Manchester Dental School, Manchester M15 6FH, U.K.

C. P. DANIELS, B.D.S., F.D.S., R.C.S. (ENG)

Department of Child Dental Health, University Dental Hospital, University of Wales College of Medicine, Heath Park, Cardiff CF4 4XY, U.K.

Abstract. *Previous studies have suggested large differences in the outcome of orthodontic treatment as measured by the PAR index in two adjacent regions of England. The aim of this prospective study was to identify any factors contributing to the mean PAR score reduction in the North Western region and the Mersey region. Forty-one practitioners submitted 375 sets of start models and 250 end of treatment models. The study ran for 36 months. There were no significant differences detected in the type of malocclusion treated or in outcome of treatment between the two regions with respect to the PAR and IOTN indices. This study did, however, clearly demonstrate that qualified orthodontic practitioners were achieving significantly better results with fixed appliances than practitioners with no orthodontic qualification who used fixed appliances.*

Index words: Occlusal Indices, Treatment Outcome.

Introduction

Several reports have suggested that there is marked inter-region variation in the outcome of orthodontic care as measured by occlusal indices. In percentage PAR reduction for example, the greatest difference was between the North Western Region with 40 per cent compared with 57 per cent for the adjacent Mersey Region (Richmond *et al.*, 1993b).

The aim of this study was to identify any factors related to percentage PAR reduction, and any reasons for the apparent difference between the North Western and Mersey Regions.

Materials and Methods

Permission was obtained from the Family Health Service Authorities and Local Dental Committees in the North Western and Mersey Regions to run the study. Information was obtained from The Dental Practice Board to identify practitioners undertaking orthodontic treatment in the General Dental Service. Dentists who completed more than 20 cases per year and also those completing less than five cases per year were highlighted. A random selection of 80 practitioners, 40 from each region was then made and letters were sent out inviting them to take part in the study. £30.00 per patient was paid to the practitioner per case to cover the expenses of taking part. As a result of this 41 practitioners, 14 from Mersey and 27 from the North Western Region agreed to take part. General practitioners completing more than 20 courses of ortho-

odontic treatment per year and qualified orthodontic practitioners were invited to send start study models of up to 20 consecutively started cases. General practitioners completing less than five cases per year were invited to send models of up to five consecutively started cases. After treatment, further models were requested, even if treatment had to be discontinued for any reason.

PAR scores, Dental Health and Aesthetic Components of IOTN were recorded for all the models supplied as has previously been described (Richmond *et al.*, 1992, 1993a). All scoring was carried out by the same examiner (N. Fox). The examiner had attended a course of instruction in the use of the indices and had been calibrated. Intra-examiner agreement was checked by repeat scoring of 50 models selected at random by computer. The models were prepared for analysis by another person (J. Wright) so the examiner did not know the practitioner or region from where each model came. Details of the appliances used, together with age of the practitioners and patients were also recorded.

Statistical Analysis

Inter-regional (unpaired) comparisons of occlusal index scores were analysed using the Mann-Whitney *U*-test. Paired comparisons were made with the Wilcoxon matched pairs signed ranks test. The inter regional comparison of appliances used was analysed using the Chi-square test. A multiple regression model was constructed to 'explain' the variation in treatment outcome (percentage PAR

reduction) in terms of treatment related variables. Intra-examiner reliability was checked using the weighted Kappa statistic. The Kruskal-Wallis test was used to compare the malocclusions across different regions and different practitioner groups.

Results

Three-hundred-and-seventy-five sets of pretreatment models were received from 41 practitioners, 214 from the North Western region, and 161 from the Mersey Region, a response rate for practitioners of 67.5 and 35 per cent, respectively. Unfortunately, seven practitioners from the North Western Region withdrew during the study and most practitioners did not provide a full quota of finished cases. After 36 months of running the study, 250 complete sets of study models had been obtained (131 Mersey and 116 North Western). There were a further 30 cases where post-treatment models were not taken. Reasons for discontinuation were available for these cases.

The Pretreatment Sample

The Kappa statistic was 0.82 for intra-examiner agreement on scoring PAR, 0.83 for DHC, and 0.78 for AC representing a high level of agreement. The mean weighted PAR and IOTN scores for each regions and a combined score is given in Table 1. The crossed-classification of pretreatment IOTN dental health scores with Aesthetic Component scores is shown in Table 2. Thirty-five cases had no need for treatment on aesthetic grounds (Grades 1-4), 152 cases were borderline (grades 5-7), and 188 had a great need for treatment on aesthetic grounds (grades 8-10). Only two cases from 365 were graded as not needing treatment on dental health grounds (grades 1-2). Twenty-nine had a borderline need for treatment (grade 3). Three-hundred-and-forty-four cases (over 90 per cent) therefore were in definite need of treatment on dental health grounds.

The Kruskal-Wallis test failed to detect differences in malocclusions across different regions and different practitioner groups implying that all practitioner groups in both regions are treating essentially the same sort of cases with respect to initial PAR and IOTN scores. It should, however, be remembered at this point that these indices are not designed to be indices of complexity.

Discontinued Treatments

Twenty-nine cases of the 250 models returned were discontinued. Reasons for discontinuation were available for a further 30 cases although unfortunately models were not available for analysis. Details are given in Table 3. The overall discontinuation rate was 21.1 per cent (16.4 per cent for Mersey and 25.7 per cent for the North Western). This is similar to previously quoted figures (DHSS, 1986). Taking both regions together there was little overall difference between specialist and non-specialist discontinuation rates at around 20 per cent. In this study completed treatments finish on average 3.7 PAR points better than

TABLE 1 Weighted PAR and IOTN scores for both regions

	Mersey		North western		Combined
	Spec	N/spec	N/spec	Spec	
Pretreatment					
	(n = 126)	(n = 35)	(n = 127)	(n = 87)	(n = 375)
PAR	30.0	28.1	29.8	28.9	29.5
AC	7.1	6.7	7.0	7.2	7.0
DHC	4.1	4.0	4.2	4.2	4.1
Post-treatment					
	(n = 105)	(n = 26)	(n = 66)	(n = 53)	(n = 350)
PAR	9.2	13.5	12.9	11.5	11.1
AC	3.1	4.5	4.2	4.2	3.8
DHC	2.6	2.9	2.8	3.0	2.8

Ninety-five percent confidence limit for PAR mean, start = 28.5 to 30.5, end = 10.1 to 12.2. Median for IOTN (AC), start = 7, end = 3. Median for IOTN (DHC) start = 4, end = 3.

Key: Spec, specialist orthodontic practitioner and general practitioners completing more than 20 cases per year; N/Spec, general dental practitioner completing less than five cases per year; AC, aesthetic component of IOTN; DHC, dental health component of IOTN.

TABLE 2 Crossed classification of pretreatment IOTN Dental Health Component by dental Aesthetic Component score for 375 cases

	DHC	2	3	4	5	Row
AC						
2		2	1		1	4
3			1	7	1	9
4			7	13	2	22
5			8	16	8	32
6			7	29	3	39
7			5	63	13	81
8				79	19	98
9				38	37	77
10				6	9	15
Column	2	29	251	93	375	

TABLE 3 Reasons for discontinuation of orthodontic treatment

Reason	Number of Patients		
	Mersey	North Western	Combined
Poor oral hygiene	3	6	9
Transfer	0	2	2
Poor co-operation	9	17	26
Patient request	6	8	14
Others	5	3	8
Total	23	36	59
Specialist	19 (17%)	23 (28%)	42 (20%)
Non-specialist	4 (14%)	13 (22%)	17 (20%)
Total	16.1%	25.7%	21.1%

discontinued treatments. This difference was statistically significant ($P = 0.030$) using a Mann-Whitney U -test, but this small difference does suggest that many discontinued cases may have still significantly benefited from treatment.

Appliance Types Used

The appliance systems used for the treatment of patients in the two regions is shown in Fig. 1 illustrating higher use of

Appliances used in the Mersey and North Western Regions

Cases where treatment was completed (n = 221)

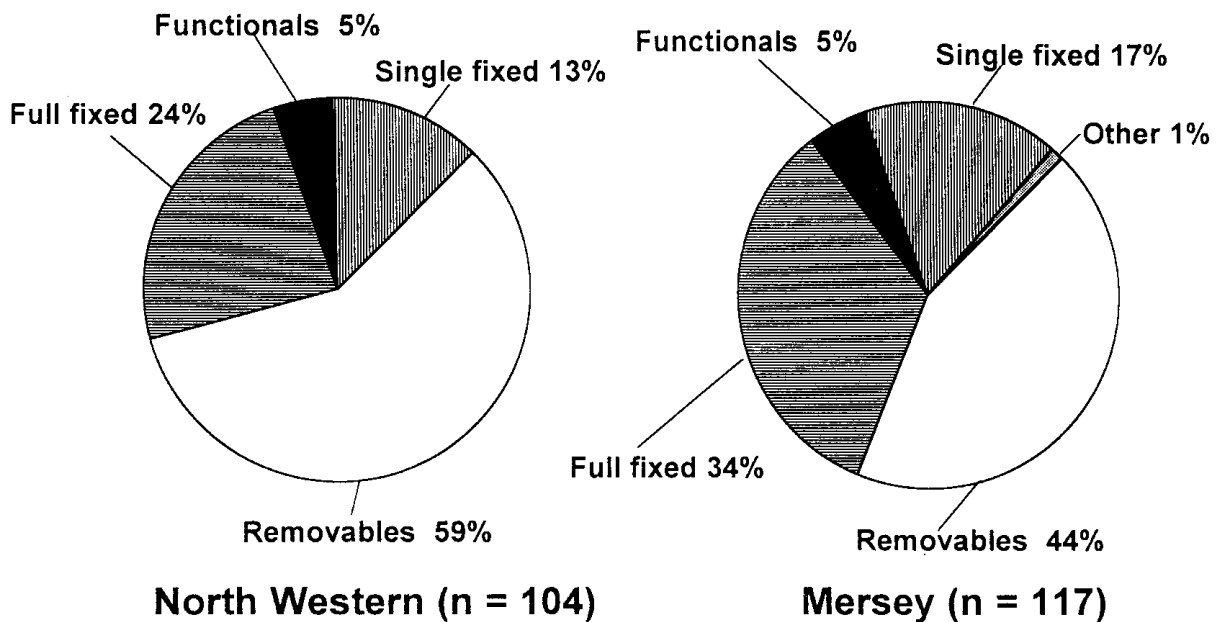


FIG. 1 Pie charts showing the appliance usage between the two regions. The increased use of fixed appliances in the Mersey Region is due to the increased proportion of specialist cases in the sample. When matching groups between regions, no significant differences exist.

fixed appliances in the Mersey Region. This is because the Mersey sample is made up of 80 per cent treated cases from specialists compared to 59.1 per cent in the North West Region. Specialist practitioners in Mersey used upper and lower fixed appliances in 45 per cent of the cases, compared to 32 per cent of specialist cases in North West. This was not significant using the Chi square Test ($P > 0.05$).

Post-treatment Outcomes

An honest appraisal of health care interventions should include analysis of all outcomes achieved in a given system. For this reason the treatment outcomes for the study were calculated to include discontinued cases. This approach provides 250 cases (of which 21 were discontinued) to assess the orthodontic outcomes in the two regions.

Index of Orthodontic Treatment Need (IOTN)

Post-treatment IOTN (AC) scores showed of the 250 outcomes, 155 now had no need for treatment on aesthetic grounds, 81 borderline need, and 14 definite need. The median start score for both regions was 7. The post-treatment IOTN (DHC) scores showed of the 250 outcomes only 63 remained in grades 4 and 5. The median start DHC score was 4 and median finish score was 3 for

both regions. No statistically significant differences were observed between aggregate post-treatment DHC scores between the regions.

The Peer Assessment Rating (PAR Index)

The results are summarised in Table 4. Statistically significant differences were found between completed and discontinued cases ($P = 0.015$), qualified orthodontic practitioners compared with general dental practitioners ($P = 0.0003$), and orthodontically qualified practitioners using fixed appliances compared with general dental practitioners using fixed appliances ($P = 0.001$).

Dentists Age/Qualifications

The mean age of practitioners taking part in this study was 44.3 years for the North Western and 41.8 Years for Mersey. Qualifications and any relevant orthodontic experience are detailed in Table 5. A *t*-test for age and a chi-square test for experience revealed no significant differences, between regions.

The mean age of patients treated in the North Western Region was 13.1 years (standard deviation 4.0 years). The mean age of patients treated in the Mersey region was 13.2 years (standard deviation 2.6 years). There was no statis-

TABLE 4 *Percentage PAR reductions*

Sample/variable examined	% PAR Reduction
Completion/non-completion of treatment	
All cases	57.8
Completed cases	59.8
Discontinued cases	42.3*
Regions compared	
Mersey cases	62.6
North western cases	52.5
Qualifications	
M.Ortho/D.Orth practitioner cases	70.0
GDP cases	49.8***
Use of fixed appliances	
M.Orth/D.Orth practitioner cases	75.5
GDP cases	61.9***

* Denotes statistical significance $P < 0.05$; *** denotes statistical significance $P < 0.001$.

TABLE 5 *Practitioners orthodontic experience*

	Number of practitioners	
	North western	Mersey
Possession of D.Orth/M.Orth Extended 2-year clinical assistant training	3	5
Attended at least one section 63 course per year on orthodontics	6	3
No postgraduate orthodontic training	3	0
Total	15	6
Total	27	14

TABLE 6 *Linear regression on percentage PAR reduction*

Variable	coefficient	Significance
Full fixed appliances (minus all others)	7.8	<0.0001*
Postgraduate degree (minus all others)	3.3	0.0079*
Completion of treatment	6.1	0.0035*
Aesthetic component of IOTN	1.7	0.0001*
Dental health component of IOTN	4.8	0.0001*
Region (M-NW)	0.0003	0.996

$R^2 = 0.34$.

* Denotes statistical significance above $P < 0.05$.

tical difference between these ages when a *t*-test was used to compare them ($P > 0.05$).

Results of multiple Regression

From the foregoing results it would seem that there are differences in outcome between regions, practitioner groups and appliance types. However, it is possible that all of these effects are related to only one factor such as appliance type, because fixed appliances were used mostly by the Mersey specialists who provided most of the Mersey sample and appeared to have the best outcomes. To examine each of these independent effects simultaneously a multiple regression model was calculated with percentage PAR reduction as the dependent variable. A stepwise method was used to select independently signifi-

cant contributors to the model. The results are shown in Table 6. The model confirms what is probably already known intuitively, that the greatest reduction in percentage PAR scores occurs when qualified practitioners using fixed appliances complete treatment on cases which have a high initial need for treatment on grounds of dental health and aesthetics

Discussion

Treatment Need

The Report of the Committee of Enquiry into Unnecessary Dental Treatment (1986) previously suggested that many courses of orthodontic treatment in the general dental services were carried out for appearance only and that many were unnecessary. It is reassuring therefore to find that 91.8 per cent of the 375 cases in this study had a definite need for treatment on dental health grounds when treatment commenced. There was no evidence from this study that a significant number of very mild cases are being treated. The cases that scored low in the aesthetic component may have traits that require correction, but do not register on the aesthetic component such as impacted teeth.

Treatment Outcomes

The initial aim of this study was to attempt to identify reasons to account for an apparent difference in treatment standards between two demographically similar and adjacent regions. No such difference could be found.

The function of PAR reduction has been used in this study as an analogue for treatment outcome, but it must be remembered that there is more to clinical outcomes than mechanical index measurements.

The regression has once again highlighted the superiority of fixed appliances in obtaining consistently high standards of orthodontic outcome. Contrary to previous studies it has also been shown that the possession of an orthodontic qualification makes a significant positive contribution to treatment outcomes with respect to percentage PAR reduction. If a greater standard of outcome is to be achieved in the general dental service it would seem sensible to try and increase the percentage of treatments carried out by specialists using fixed appliances. It was assumed that the appliances used by practitioners were the most appropriate to a particular case. In certain situations, such as patient resistance, it may not be appropriate to use advanced appliances. However, it should be borne in mind that appliance choice may markedly compromise the standard of outcome, and such choices can only be made in the patient's interest by practitioners conversant with all appliance types.

Shortcomings of this Study

The study may be criticised in that the number of practitioners was rather small, but despite financial compensation, no more were prepared to take part. It could also be argued that only the more 'motivated' practi-

tioners took part in this study and it is therefore biased, but this should not lead to a different 'type' of practitioner taking part from each region. In fact, with respect to age, qualification, and experience no such difference was detected between the two regions. Close monitoring of practitioners results although anonymous, may encourage a higher standard of treatment. This should not affect one region more than another, but it may have contributed to the higher PAR reductions seen in this study.

It is notable that, despite the inclusion of incomplete cases in the summary analysis, it would appear that the outcomes obtained for both regions are better than the previously published estimates (Richmond *et al.*, 1993b).

Kelly and Springate (1996) found that orthodontically qualified practitioners were obtaining a very high percentage PAR reduction of 89 per cent. The sample of 200 cases was, however, limited to consecutively completed cases using full fixed appliances only. Other appliance types and discontinued cases were therefore excluded. Power *et al.* (1996) carried out a retrospective study of 172 completed cases treated by practitioners in their own practice who had undergone clinical assistant training in hospital orthodontic departments. All appliance types were used and a percentage PAR reduction of 62.8 per cent was observed. Discontinued cases were again excluded as were cases thought to be 'interceptive' for example, crossbite correction in the mixed dentition. Whilst there may be justification for this (Fox, 1993; Kerr *et al.*, 1993), it can be seen that sampling techniques should be examined closely when comparing studies.

It should be stated that the sampling method for this survey (prospective, consecutively started cases) was different from that undertaken at the Dental Practice Board (retrospective systematic 5 per cent sample of completed cases). This may account for the difference with previous studies (Richmond *et al.*, 1993b).

Conclusions

1. With respect to PAR and IOTN, the initial malocclusions being treated in the North Western and Mersey regions were not significantly different.
2. Overall, significant differences in outcome, between the two regions were due to the differences in the use of fixed appliances, specialist practitioner qualification, and completion of treatment.

3. Accepting the limitations of the small sample size, qualified orthodontic practitioners using fixed appliances are providing a good quality service in the general dental service.

Acknowledgements

The authors would like to thank our colleagues in the North Western and Mersey regions who kindly agreed to take part in this study, and The North Western Regional Health Authority for its financial support.

References

DHSS (1986)

Report of the Committee of Enquiry into Unnecessary Treatment, HMSO, London.

Fox, N. A. (1993)

The first 100 cases: a personal audit of orthodontic treatment assessed by the PAR (peer assessment rating) index, *British Dental Journal*, **174**, 290–297.

Kelly, B. M. and Springate, S. D. (1996)

Specialist orthodontics in the General Dental Service, *British Dental Journal*, **180**, 209–215.

Kerr, W. J. S., Buchanan, I. B. and McColl, J. H. (1993)

Use of the PAR index in assessing the effectiveness of removable orthodontic appliances, *British Journal of Orthodontics*, **20**, 351–357.

Power, S. M., Hodgkins, J. F., Stephens, C. D. and Webb, W. G. (1996)

An investigation into the standard of orthodontic treatment carried out by GDPs after completion of a clinical assistant training, *British Dental Journal*, **180**, 91–97.

Richmond, S., Shaw, W. C., O'Brien, K. D., Jones, R., Stephens, C. D. Roberts, C. T. and Andrews, M. (1992)

The development of the PAR index (peer assessment rating): reliability and validity, *European Journal of Orthodontics*, **14**, 125–139.

Richmond, S., Andrews, M. and Roberts, C. T. (1993a)

The Provision of Orthodontic Care in the General Dental Services of England and Wales: extraction patterns, treatment duration, appliance types and standards, *British Journal of Orthodontics*, **20**, 345–350.

Richmond, S., Shaw, W. C., Stephens, C. D., Webb, W. G., Roberts, C. T. and Andrews, M. (1993b)

Orthodontics in the General Dental Service of England and Wales: a critical assessment of standards, *British Dental Journal*, **174**, 316–329.