ORIGINAL ARTICLE

Comparing orthodontic treatment outcome between orthodontists and general dentists with the ABO index

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This study used the American Board of Orthodontics (ABO) Objective Grading System (ABO index) (ABOI) to compare treatment outcome between patients treated by orthodontic specialists (OS) and patients treated by general dentists (GP). The sample (n = 196) consisted of 126 dental casts of patients treated by OS and 70 treated by GPs. All casts were collected in 1997 and 1998 from 10th grade students attending high schools in Cuyahoga County, Ohio, and were scored by 1 operator (Y.A.) calibrated in the use of the ABOI. The mean ABOI score for the OS group was 26.0 ± 11.4 compared with 29.6 ± 12.8 for the GP group. This difference was significant at the $P \leq .05$ level. Of the 7 components used in the ABOI, alignment of teeth was found to be the most significant between groups (OS mean = 5.39 ± 4.37 versus GP mean = 7.8 ± 5.21, $P \leq .0007$). In this sample, a significantly lower ABOI score was found for patients treated by OS compared with patients treated by GP. (Am J Orthod Dentofacial Orthop 2004;126:544-8)

As dentistry's oldest specialty, orthodontics and orthodontists have claimed a priori that we provide better orthodontic services than other dental practitioners. The recognition as a specialty by the American Dental Association, along with 2700 curricular hours of instruction over a minimum of 24 months, supports our position. However, there is little quantitative evidence that this additional education, while certainly impressive, results in better treatment for patients. Over the past 100 years, specialty training alone has been enough to allow our position as the preferred orthodontic providers to remain unquestioned. However, what if we were challenged to provide external validation for our claim to the mantle of orthodontic superiority?

Evidence-based decision-making has become a hallmark of 21st century healthcare, and this trend has placed a premium on quantitative measures of treatment outcome. Finding valid measures of treatment success is important for both health care providers and health care consumers. Dental consumers are interested in value—obtaining the best quality service at the lowest cost. Likewise, providers would like to know which treatments are most effective, ie, have the best chance of success. In fee-for-service professions, such as orthodontics, the patient or the patient's parent can obtain cost information by asking for fee quotes from several offices in the area. However, comparing the quality of orthodontic treatment is more difficult. Malocclusion is not a disease; rather, it is a collection of morphologic conditions with an indefinite cutoff value between normal and abnormal. Improved facial appearance, often considered a desirable outcome of orthodontic treatment, is subjective and "in the eye of the beholder." Because these components of orthodontic treatment outcome are elusive, it might never be possible to make evidence-based decisions in all clinical situations. This means that good clinical judgment will always be needed to ensure optimum care for each patient. Likewise, a single measure of treatment outcome cannot estimate the value of specialty training. However, to the extent possible, we should try to quantitate treatment outcome and compare our results with some standard of care. Therefore, in this era of evidence-based dentistry, quantitative measures are essential.

Although many aspects of orthodontics are not easily measured, several valid and reliable indexes have been developed to evaluate the alignment of the teeth

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before and after orthodontic treatment. One of the most popular indexes of dental alignment is the peer assessment rating (PAR) index.[1-3] The PAR index was used during the last decade in both the United States and the United Kingdom to compare the outcomes of various orthodontic treatment strategies.[4,5] The strength of the PAR index is its ease of use, reliability, and validity. It uses both the before and after treatment study casts to measure the relative alignment of the teeth according to 5 criteria (US system) or 7 factors (British weighting).[3,6] Studies using the PAR index have provided evidence that the alignment of the teeth is similar in extraction and nonextraction patients,[7] and between patients treated in 1 phase and 2 phases.[8] However, the PAR index has some limitations. First, it measures only 1 outcome of treatment, ie, straight teeth. Second, it requires both before and after study casts to generate a valid score. And third, it might not capture all the fine details of dental alignment.

To address these issues, a new index of dental alignment was developed by the American Board of Orthodontists (ABO).[9] The ABO index (ABOI) was designed to evaluate finished study casts to determine whether the finished case met the ABO's standards for alignment of teeth. The 8 criteria summed to yield the ABOI score were chosen by the ABO examiners. These 8 criteria cover 85% of the mistakes that examiners see in the Phase III examination. A unique factor of the ABOI is that it uses only the final models and does not require initial study casts to generate a score. Recent reports in the literature[10] have shown that 75% of the patients finished by orthodontic residents in training meet or exceed the ABOI standards. The ABOI is gaining increased recognition in the orthodontic profession as a valid measure of excellence in orthodontic finishing.

The purpose of this study was to compare orthodontic treatment outcome in a sample of patients divided on the basis of orthodontic provider education by using 2 outcome measures. The first measure was the patient's perception of the improvement in his or her smile. A visual analog scale (VAS) was used to estimate this variable. Second, we used the ABOI to compare the alignment of the teeth. The goal was to obtain evidence to support the commonly held belief that orthodontic specialists provide better orthodontic care than do general dentists.

MATERIAL AND METHODS

Survey data were obtained from 2808 students in the 10th grade at 20 high schools in Cuyahoga County, Ohio, in 1997 and 1998. The details of subject recruitment have been previously described.[11] Of the 2808 subjects, 1047, or 37%, received orthodontic treatment. Impressions were obtained as described below on 255 treated subjects. Some impressions were distorted, and, in some instances, the provider was unknown, reducing the number of useful subject impressions to 196; there were 70 for subjects treated by nonorthodontists and 126 for subjects treated by orthodontic specialists.

Each student received a plastic bag that contained a disposable impression tray (Royal Industries, Industry, Calif), 2 scoops of President impression material (Coltene/Whaledent, Mahwah, NJ), and a dental napkin. While seated at their classroom desks, the students were shown how to mix the material, load the impression tray, and insert the tray into their mouths. By biting down into the soft material, an impression of the maxillary and mandibular teeth was recorded, along with the bite registration. When the impression material had set, the trays were placed back in the plastic bag and all materials collected. In the dental laboratory, the impressions were disinfected and poured in dental stone.

All casts were scored with the ABOI, as previously described.[9] Briefly, each set of dental casts was articulated in maximum intercuspation position. A single investigator (Y.A.), who was blinded to provider identity, scored all 196 casts. The investigator was calibrated using the ABOI calibration kits under the supervision of ABO director, Dr Mike Riolo. The ABOI score was the sum of the 7 dental cast measurements that contributed to the ABOI (Table I). Root angulation scores were not included because these measurements require panoramic radiographs, which were not available. For the ABO Phase III examination, an ABOI score greater than 35 is usually failing. A score less than 20 is generally passing; 26 is the borderline score for passing.

The 196 casts were divided into 6 groups: excellent, ABOI less than 10; good, ABOI score 11-19; probably would pass, ABOI score 20-26; might not pass, ABOI score 27-34; poor, ABOI score 35-45; and very poor, ABOI score over 45.

All VAS scores were obtained as part of the 1997 and 1998 surveys and followed the protocol established by Johnston et al.[12,13] Students were asked how they felt about their teeth or smile before and after treatment by marking two 100-mm scales. The descriptive term "terrible" was used to anchor the left side of the scale and assigned a score of 0. "Great" was used to anchor the right side and assigned a score of 100. By using a millimeter ruler, the distance from the left side of the scale to the student's mark was measured and recorded as the VAS score.

The Statistical Package for the Social Sciences (SPSS, Chicago, Ill) was used for statistical analysis. A P value of

Table I. ABOI scores by provider type

	Orthodontic specialists (n = 126)	*Nonorthodontists (n = 70)*	P *value*
Total	26.0 ± 11.4	29.6 ± 12.8	.04
Alignment	5.39 ± 4.37	7.8 ± 5.21	.0007
Marginal ridges	3.92 ± 2.87	4.4 ± 2.87	.27
Buc-lingual inclination	4.51 ± 4.03	4.18 ± 3.02	.55
Occlusal contact	4.05 ± 4.34	4.91 ± 5.21	.22
Occlusal relation	3.11 ± 3.44	3.30 ± 3.48	.71
Over Jet	4.20 ± 3.96	3.77 ± 3.10	.43
Interproximal contact	0.78 ± 1.49	1.21 ± 2.77	.15

.05 was used to assign statistical significance. *T* tests were used to compare ABOI scores and VAS score improvement achieved by the 2 provider groups.

RESULTS

Forty four percent of the subjects in the final sample (n = 196) were male with a mean age of 15.4 ± 0.65. The mean before and after treatment VAS scores were 36.7 ± 22.7 and 77.4 ± 17.4 for patients treated by nonorthodontists and 35.4 ± 22.7 and 79.7 ± 16.3 for patients treated by orthodontic specialists. The before and after differences in VAS score were significant for both provider groups ($P \leq .05$). However, there was no statistical difference between the 2 provider groups (Table II).

The mean posttreatment ABOI scores were 29.6 ± 12.8 for patients treated by nonorthodontists and 26.0 ± 11.4 for patients treated by orthodontic specialists (Table I). This difference was significant ($P \leq .05$). The alignment section of the ABOI demonstrated the largest difference ($P \leq .0007$). The alignment section was further divided into 4 components: maxillary anterior (canine to canine) alignment, mandibular anterior alignment, maxillary posterior alignment (second premolar to second molar), and mandibular posterior alignment (Table III). When these 4 components were analyzed separately, mandibular posterior alignment showed the most significant difference ($P < .00006$).

The 196 casts were sorted into 6 outcome groups as shown in Table IV. Orthodontists had a higher percentage of casts in the excellent and good categories. However, the measured ABOI scores in this study do not include root angulation measurements.

DISCUSSION

The purpose of this study was to compare the outcome of orthodontic treatment provided by orthodontic specialists with that provided by general dentists by using 2 measures of success—dental alignment (ABOI) and the patient's perception of improvement

Table II. VAS score by provider

	Orthodontic specialists (n = 126)	*Nonorthodontists (n = 70)*	P *value*
Before treatment	35.4 ± 22.7	36.7 ± 22.7	.71
After treatment	79.7 ± 16.3	77.4 ± 17.4	.38

(VAS). The results demonstrate significant differences in the alignment of teeth, especially in the molar area. Orthodontists achieved superior alignment scores for teeth in all areas of the mouth. However, the magnitude of the differences from canine to canine was not large enough to be statistically significant. It is possible that these differences would be significant if the sample size, especially for general dentists, were increased and the mean difference remained unchanged. In addition, it is likely that specialists treated more severe malocclusions, and, therefore, the difference is probably underestimated in our sample of providers.

Although many factors, such as facial balance, smile esthetics, and function, are commonly associated with successful orthodontic treatment, one of the most basic outcomes that certainly must be achieved is straight teeth. Because both providers are dentists, it is not surprising that both groups could align teeth effectively. Our data suggest that specialists placed braces on second molars more often than their general dentist colleagues. Incorporating second molars into the appliance strap up would result in improved alignment between first and second molars and is consistent with our findings.

Although there were significant differences in ABOI scores, there was no difference in VAS scores. Apparently, patients did not see any differences in the outcomes of treatment based on provider. Importantly, they were universally pleased with their smiles after treatment. One possible explanation for this finding is that patients can see their front teeth but not their posterior occlusions. This explanation is consistent with the ABOI results because the largest differences between provider groups were in the molar area. It is also likely that factors unrelated to treatment outcome influenced patient satisfaction scores. Some factors patients might consider include the personality of the provider and the staff members, the appearance of the provider's office, and the speed of treatment. It is certainly gratifying to know that our patients appreciate that orthodontic treatment improves their smiles. The improvement in posttreatment VAS scores supports this belief. Unfortunately, the data suggest that patients cannot perceive occlusal differences that seem to char-

Table III. Breakdown of alignment section

	Orthodontic specialists (n = 126)	*Nonorthodontists (n = 70)*	P *value*
Maxillary anterior alignment	1.27 ± 1.85	1.60 ± 1.89	.24
Maxillary posterior alignment	1.19 ± 1.49	1.67 ± 1.73	.05
Mandibular anterior alignment	1.67 ± 2.12	2.29 ± 2.54	.09
Mandibular posterior alignment	1.21 ± 1.42	2.34 ± 2.02	.00006

Table IV. ABOI score distribution by provider type

	Total		*Orthodontic specialists*		*Nonorthodontists*	
Score	*n*	*Percentage**	*n*	*Percentage**	*n*	*Percentage**
<10	4	2%	4	3%	0	0%
11–20	49	25%	37	29%	12	17%
21–26	55	28%	33	26%	22	31%
27–35	44	22%	29	23%	18	26%
36–45	26	13%	18	14%	8	11%
>45	18	9%	8	6%	10	14%
Total	196	100%	126	100%	70	100%

*Percentages do not add up to 100% because decimals were less than 4/10 and could not be rounded.

acterize the orthodontic treatment outcomes between provider groups.

Finally, we must consider the finding that neither provider group consistently achieved the level of quality required to pass the ABO Phase III examination. The overall mean ABOI score for both groups was 27.27 ± 27. According to ABO guidelines, a case score of 30 or more points will fail, and a score less than 20 will generally pass the ABO Phase III examination. A score of 26 is considered borderline for passing. In addition to scoring the dental casts, ABO examiners score root angulations using panoramic radiographs. If root angulations were scored, the mean ABOI score would be higher than we reported. Board examiners also evaluate the quality of the records and the appropriateness of the treatment plan. They can also consider whether the practitioner achieved the stated objectives for the maxilla, mandible, maxillary dentition, mandibular dentition, and facial profile. Because a score less than 20 was achieved by orthodontic specialists in 32% of their patients, whereas nonorthodontists achieved this score in less than 17% of theirs, patients are twice as likely to receive board-quality treatment in a specialist's office. The last report issued by the ABO in 2001 indicated that only 23% of orthodontic specialists were board certified. This is unfortunate because without objective indexes for facial profile, skeletal balance, beauty, and function, board certification can be an important indicator of orthodontic excellence.

Today, success in orthodontic practice seems to be measured in terms of case starts and patient satisfaction surveys. Many orthodontic continuing education courses focus on increasing the number of patients seen per day, reducing doctor-patient contact time and finishing cases as soon as possible. The management experts sometimes say that, as long as the front teeth are straight, the case is finished. The present study shows that patients cannot tell the difference between the results of specialists and nonspecialists just by looking. Because patients are attracted to practitioners with people skills and can be influenced by the number of video games in the waiting area, the motivation to provide high-quality results is internal. Confucius said, "The superior man seeks what is right; the inferior one, what is profitable."[14] Isn't it ironic that, just when "putting the plaster on the table" is considered old-fashioned and most orthodontists are not board certified, these factors are the outcome measures that separate specialists from general practitioners.

Limitations

Although occlusal indexes are quick, valid, and accurate methods for assessing orthodontic treatment results, they measure only 1 aspect of orthodontic treatment outcome. Changes in facial profile, improved skeletal balance, and function were not measured in this study. The inclusion of these important parameters would greatly improve studies on orthodontic treatment outcome. Unfortunately, standards for quantitative as-

sessment of these traits have not been developed to date and, therefore, were not included in this study.

All study casts were articulated in maximum intercuspation position rather than in centric relation. In addition, when there was any doubt about the best fit of the teeth in maximum intercuspation, the casts were articulated with the molars in Class I position. Because this method would not capture incomplete Class II corrections, ie, "Sunday" bites, it is possible that we have overestimated the quality of the results achieved. Likewise, patients were not separated into those wearing retainers and those who were not. This introduces a question about whether the superior results achieved by the orthodontic specialists were due to superior alignment at the end of treatment or superior cooperation from patients wearing retention appliances. One must assume that retainer compliance was similar between provider groups. This is a reasonable assumption because the difference in alignment between groups was due to improvement in the molars, and better retainer wear would most likely impact anterior alignment.

CONCLUSIONS

In this sample, significantly lower ABOI scores were found for patients treated by orthodontic specialists compared with patients treated by general dentists.

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