ORIGINAL ARTICLE

Practice-based comparison of direct and indirect bonding

S. Thomas Deahl,[a] Norman Salome,[b] John P. Hatch,[c] and John D. Rugh[d]
Concord, Calif, and San Antonio, Tex

Introduction: The purpose of this study was to compare bond-failure prevalences, numbers of appointments, and treatment times between direct and indirect bracket bonding for patients treated in private orthodontic practices. **Methods:** A convenience sample was collected from 11 orthodontic offices; 5 orthodontists (772 patients) used a direct bonding technique, and 6 (596 patients) used an indirect technique. Altogether, they examined 29,963 brackets in 1,368 patients. Bond failures were recorded by tooth number and by patient during 10 consecutive practice days. In addition, the orthodontists reported the treatment time and number of visits for each of their 10 most recently completed comprehensive patients. **Results:** The per-patient debond prevalences were 1.17% ± 3.62% for direct bonding and 1.21% ± 3.81% for indirect bonding ($P = .225$). Direct-bonded patients required a mean (± SD) treatment time of 750 ± 220 days and 22.0 ± 7.3 visits; indirect bonding required a mean treatment time of 745 ± 256 days and 22.2 ± 7.3 visits ($P = .691$ and $P = .653$, respectively). **Conclusions:** This practice-based study showed no difference in the failure rates between direct and indirect bonding. Furthermore, total treatment times and numbers of appointments did not differ between the 2 techniques. (Am J Orthod Dentofacial Orthop 2007;132:738-42)

Many authors have discussed the comparative advantages of direct and indirect bonding for orthodontic brackets.[1-7] Theoretically, indirect bonding permits more accurate bracket placement because of the ability to see the bracket position from many different angles, but laboratory studies showed mixed results.[1,2,4,6,7] Although some studies show that indirect bonding permits better bracket placement on some teeth and in some planes of space, there is no clear advantage across the board. This modest placement advantage on individual teeth might not lead to a clinically significant difference for the patient in terms of treatment time or number of visits. Furthermore, any benefit from better bracket placement with indirect bonding could be offset by higher bond-failure rates. Laboratory studies indicate that direct and indirect bonding techniques yield similar bond strengths under ideal conditions.[2,3,5] However, clinically, there is less control of the indirect-bonding environment, and indirect bonding has not been tested in vivo for bond strength or bracket-failure rates. Because it is technique sensitive, indirect bonding might lead to more bracket failures in an actual clinical environment.

The main shortcoming of the previous research comparing direct and indirect bonding is that all were laboratory studies.[2-7] In these studies, the authors measured bond strength on extracted teeth and attempted to measure the accuracy of bracket placement. Both variables are surrogate measures. True endpoints would have to measure variables that have some tangible patient benefit, such as number of broken brackets, the quality of the finished result, or the length of treatment time. Another major shortcoming of many previous studies was that the same practitioner performed both techniques. This can introduce bias if the practitioner is more skilled with 1 technique. The critical question is the relative effectiveness and efficiency of direct and indirect bonding in clinical settings when experienced orthodontic teams routinely perform that type of bonding.

Practice-based research has been conducted for over 20 years in various medical disciplines,[8-11] but it has been seldom used in dental research.[12] Practice-based research enlists the wisdom and experience of community-based clinicians in designing and conducting immediately relevant research projects.[13] Practice-based research complements traditional, university-based research by (1) enrolling a broader spectrum of patients who might be more representative of the

[a]Lecturer, Institute for Natural Resources and Biomed General Corporation, Concord, Calif; Adjunct associate professor, Department of Orthodontics, University of Texas Health Science Center at San Antonio.
[b]Clinical assistant professor, Department of Orthodontics, University of Texas Health Science Center at San Antonio.
[c]Professor, Department of Orthodontics and Psychiatry, University of Texas Health Science Center at San Antonio.
[d]Professor and chair, Department of Orthodontics, University of Texas Health Science Center at San Antonio.
Reprint requests to: S. Thomas Deahl, UTHSCSA Department of Orthodontics, 7703 Floyd Curl Dr, San Antonio, TX 78229; e-mail, deahl@uthscsa.edu.
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community than the patients of academic health centers (improved external validity); (2) including a broader spectrum of clinicians whose experiences, skills, armamentariums, and techniques are more diverse than those in typical academic health clinic studies (improved generalizability); (3) providing access to more patients, and therefore larger samples or shorter study durations, than studies in academic health centers; (4) potentially accelerating the transfer of sound research findings to clinical practice; and (5) necessarily addressing questions of direct clinical relevance, because practice-based research requires the voluntary participation of community-based clinicians.

We aimed to use the power of the practice-based research methodology to evaluate direct vs indirect bonding. We compared bond failure prevalence, treatment time per patient, and number of appointments per patient between orthodontists who use direct bonding and those who use indirect bonding, as these techniques are currently implemented in their offices.

MATERIAL AND METHODS

We proposed this project at a meeting of the Alamo Area Orthodontic Study Club of San Antonio and refined it with the input of several private-practice clinicians. Eleven orthodontists from San Antonio and Austin, Texas, volunteered to collaborate. *Participants* here means the orthodontists and the staff members whom orthodontists invited to help with data collection. To comply with institutional review board policy, we gave all participants a detailed information sheet describing the study; each participant's voluntary decision to collaborate then signified his or her informed consent.

The institutional review board of the University of Texas Health Science Center at San Antonio reviewed and approved the project before orthodontist recruitment. The institutional review board agreed that the patients need not be informed of the study because of its noninterventional design. We recorded no traceable patient identifiers in conducting this project. The participants and all but 1 investigator (S.T.D.) were blind to office-specific data.

Five participating orthodontists had used direct bonding exclusively for at least 2 years. The other 6 orthodontists had at least 2 years' experience in using indirect bonding.

The study design included 2 elements: (1) a cross-sectional measurement of bond failure prevalence for all comprehensive patients during 10 consecutive business days per practice, and (2) a retrospective review of the total treatment times and number of visits of the 10 most recently completed patients in each orthodontist's office.

We provided standardized instructions about the project, both written and in person, to all study participants. These instructions described the aims, methods, and rationale of the study, confidentiality measures, data collection procedures and forms, and inclusion/exclusion criteria as described below.

We asked the participants to include only comprehensive patients, defined as "patients who have full fixed appliances on the upper and lower arches, whose treatment originally was planned to last at least 1 year." We allowed each practice to determine which patients met these criteria. For the cross-sectional study of bond failure, all comprehensive patients were to be included. For the retrospective study of treatment time and number of appointments, the following patients were excluded: surgery cases; 2-phase treatment cases; cases terminated prematurely; patients who had transferred into, or out of, the practice during treatment; craniofacial anomaly patients (such as cleft lip or palate) even if nonsurgical; and cases treated with nontypical bonding (such as direct bonding used occasionally by the indirect-bonding orthodontists).

We asked all orthodontists to use their current bonding materials and techniques, because we aimed to compare the performance of direct to indirect bonding as used in community-based practices.

For each comprehensive patient under current treatment during the defined 10 consecutive days of clinic operation, the orthodontists recorded intact bonded brackets and unintentional debonds since the last appointment by patient and by tooth number. No other patient-specific data were recorded.

The proportion of failed bonds per patient was calculated by dividing the number of bond failures by the number of teeth bonded. Proportions were transformed by using an arcsin transformation and analyzed with a 2-factor mixed model analysis of variance (ANOVA). The data were analyzed as proportions, but the debond prevalences are reported as percentages.

For each of the 10 most recently completed comprehensive patients, the orthodontists recorded treatment start date, treatment completion date, and the total number of visits during treatment. The orthodontists also recorded missing teeth, whether the patient had extractions, and the patient's age.

Table I. Prevalence of bond failures with direct and indirect bond placement

Orthodontist	*Patients (n)*	*Intact bonds (n)*	*Failed bonds (n)*	*Bond failure prevalence per patient (mean ± SD %)*
Direct bonding				
A1	154	3176	22	0.67 ± 2.22
A2	63	1069	39	3.44 ± 7.57
A3	208	3381	44	1.47 ± 4.27
A4	125	3059	24	0.83 ± 2.26
A5	222	4988	39	0.79 ± 2.12
Group mean (n = 772)				1.17 ± 3.62
Indirect bonding				
B1	43	751	40	5.24 ± 8.88
B2	215	3675	31	0.81 ± 2.55
B3	166	3083	41	1.22 ± 3.74
B4	31	539	5	1.08 ± 2.63
B5	49	1156	11	0.93 ± 2.98
B6	92	1783	7	0.40 ± 1.52
Group mean (n = 596)				1.21 ± 3.81

Table II. ANOVA source table for analysis of bond failure

Source	*Patients (n)*		*Mean square*	*F*	P *value*
Treatment	0.009	1	0.009	1.47	.225
Practice within treatment	0.713	9	0.079	13.42	<.001
Error	8.01	1357	0.006		

Table III. Results of retrospective study of 10 most recently completed comprehensive patients per office

	Bond type	*Number*	*Mean*	*SD*	*Range*
Treatment time (d)	Direct	50	750	220	419-1565
	Indirect	50	745	256	377-1602
Visits (n)	Direct	50	22.0	8	9-48
	Indirect	50	22.2	7	12-43

Data analysis

The mean treatment time (in days) and the mean number of visits were calculated per group. A 2-factor mixed model ANOVA was used to compare mean duration of direct and indirect bonding, with statistical significance defined as $P < .05$. Bond type was treated as a fixed effect because we studied only these 2 treatment methods. The orthodontic practices were nested in the treatment groups because each practitioner used only 1 bonding technique. The orthodontist within bond type was modeled as a random effect because selection of practices involved a sampling process. Both days and visits were transformed by taking base 10 logarithms to normalize the distributions. The data are reported as untransformed means and standard deviations.

RESULTS

In the 10 consecutive practice days, the direct-bonding orthodontists recorded data from 15,841 direct-bonded brackets in 772 patients, and the indirect-bonding orthodontists recorded data from 11,122 indirect-bonded brackets in 596 patients. The mean per-patient debond prevalences were 1.17% ± 3.62% for direct-bonded brackets and 1.21% ± 3.81% for indirect-bonded brackets, a nonsignificant difference (F[1,1357] = 1.47, $P = .225$]. Table I gives the per-patient bond-failure frequency in each orthodontic practice, along with the number of patients from each practice. Table II shows the ANOVA for bond failure.

We also analyzed the bond-failure rate for each tooth and found no significant differences between direct and indirect bonding at any site.

One indirect-bonding orthodontist did not participate in the retrospective study; data from the remaining 10 offices are reported. The results by office are shown in Table III. Mean total treatment times did not differ significantly between direct (mean ± SD 750 ± 220 days) and indirect (745 ± 256 days) bonding (F[1,90] = 0.16, $P = .691$). Table IV displays the ANOVA for treatment time.

Total visits per patient did not differ between direct and indirect bonding. Mean visits were 22.0 ± 7.9 for direct bonding and 22.2 ± 7.3 for indirect bonding [F(1,90) = 0.20, $P = .653$]. Table V shows the ANOVA for the numbers of appointments.

Table IV. ANOVA source table for treatment time

Source	Sum of squares	df	Mean square	F	P value
Treatment	0.002	1	0.002	0.16	.691
Practice within treatment	0.619	8	0.077	6.17	<.001
Error	1.129	90	0.013		

Table V. ANOVA source table for number of visits

Source	Sum of squares	df	Mean square	F	P value
Treatment	0.003	1	0.003	0.20	.653
Practice within treatment	0.886	8	0.111	8.12	<.001
Error	1.117	90	0.014		

DISCUSSION

Our aim in this study was to answer the question "what is the performance of direct vs indirect bonding as it is applied in private practice?" We found that direct and indirect bonding do not differ significantly in the prevalence of debonding or in mean treatment time per patient or mean number of appointments per patient.

Direct bonding is far more common than indirect bonding, and, before practitioners change their office protocol to an indirect technique, they will want to know the relative advantages and disadvantages of indirect bonding. Proponents of indirect bonding claim that the increased precision of bracket placement leads to greater treatment efficiency with a straight-wire technique; however, this was not shown in this study. Either the bracket placement difference was not clinically significant or the difference was made up for during treatment without extending the treatment time. Some practices might experience more bond failures after a recent change to indirect bonding, because of the learning curve associated with the new technique. Our results suggest that the bond-failure rates are comparable in practices that routinely use these bonding techniques. Therefore, there should be no long-term difference in the bond-failure rate when considering the advantages and disadvantages of indirect bonding.

This project illustrates the unique strengths of a practice-based research network. Although laboratory studies can measure bracket placement precision and bond strength, they cannot measure the endpoints that are most important to patients and practitioners—overall treatment efficiency and bond-failure rates. Furthermore, direct and indirect bonding were evaluated as they are used by staffs well trained in each technique. Since there is a large learning curve associated with any bonding technique, the outcomes must be measured in the actual clinical setting.

Because of the many variables that affect both bond-failure rates and treatment efficiency, it is critical to evaluate these across several practices. A large sample size (we studied 26,963 brackets) can be obtained in a short time (10 consecutive business days), and this makes feasible the study of relatively rare events (such as bracket failure) in a private-practice setting.

In March 2005, the National Institute for Dental and Craniofacial Research funded the establishment of 3 general dental practice-based research networks to "investigate with greater scientific rigor everyday issues in the delivery of oral healthcare. The impetus behind the networks is the frequent lack of research data to guide treatment decisions in the dentist's office."[14] Our study of direct and indirect bonding demonstrates the power and practicality of practice-based research in orthodontics.

CONCLUSIONS

The results of this research suggest that bond-failure rate, treatment duration, and number of appointments should not influence the choice of bonding technique in a private practice. Many differences between these techniques were not evaluated in this study. Orthodontists can choose one or the other based on cost, laboratory time, chair time, patient acceptance, quality of the finished results, or personal preference. These are areas for possible future studies.

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