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The selection and clinical application of dental adhesives by general dental practitioners in New Zealand

Al-Kindi F, Al-Harrasi R, Coimbatore H, Aziz S, Thomson WM, Ekambaram M

Abstract

Background: Dental adhesives are very widely used in dentistry, and appropriate selection and use is critical for their effectiveness. This study aimed to elucidate the knowledge of New Zealand general dental practitioners (GDPs) in the selection and clinical application of dental adhesives.

Methods: A questionnaire was sent to 800 GDPs. Participants answered questions on their socio-demographic characteristics, selection and clinical application of dental adhesives.

Results: The response rate was 29%. Nearly 60% of the respondents were within 30 years of graduation, and more than half were practising in major cities. Fewer than a quarter of respondents mentioned that cost was a criterion in choosing a dental adhesive system, while the remaining respondents chose adhesives based on either the number of steps required for the application and/or the manufacturer. One third reported not following the manufacturer's recommendations. Almost all dentists were aware that the improper handling and storage of adhesives will affect clinical performance. Approximately half reported always selectively etching enamel (when using self-etch adhesives) and most (90%) check their triplex syringe for any water leaks before blow-drying the primer.

Conclusion: There was uncertainty among GDPs about which type of dental adhesive to use and its proper handling in clinical practice.

Introduction

The introduction of the concept of adhesion in dentistry (Buonocore 1955) has revolutionised treatment philosophy. In modern-day dentistry, there are many applications of adhesion. The spectrum of this application extends from placing pit-and-fissure sealants on teeth for caries prevention at one end, to the luting of indirect fixed restorations at the other. Moreover, the contemporary principles and practice of minimally invasive dentistry would not be possible without dental adhesion. Despite substantial improvements in adhesive systems over recent years, the bonded interface remains the most challenging part of tooth-coloured restorations. Any contamination of the dentine and adhesive interface will result in marginal discolouration and poor marginal adaptation, and could lead to loss of restoration retention (Breschi et al. 2007; Haak et al. 2018).

Dental adhesives enable bonding of resin-based materials to the tooth substrate by first adhering to the tooth substrate and then to the resin-based restoration or cement. Micromechanical bonding to the enamel and dentine is the primary mechanism, achieved by an exchange process in which the inorganic tooth material is replaced by resin monomers (Van Landuyt et al. 2007; Perdigão et al. 2021). In addition to micromechanical bonding, chemical bonding can also be achieved by dental adhesives that contain MDP (10-Methacryloyloxydecyl dihydrogen phosphate). An excellent adhesion should have good seal along the margins of a restoration, in order to prevent leakage and restoration failure. Hence, an ideal approach for prolonging the clinical lifetime of bonded restorations would be to achieve a durable bond of these biomaterials to tooth tissue (De Munck et al. 2005).

Typically, dental adhesives comprise a mixture of multiple ingredients, and a good understanding of these materials is one of the keys to better clinical success rates. Dental practitioners use dental adhesives in their daily work. Although the literature on dental adhesives is considerable, it lacks some critical information about dentists' knowledge of (and reasons behind choosing) dental adhesives. The wide range of dental adhesive products currently available in the market may confuse practitioners. It is also essential to know the methods dentists adopt in their clinical application of dental adhesives. Accordingly, this survey investigated the selection and clinical use of dental adhesives by New Zealand general dental practitioners (GDPs).

Methods

A nationwide electronic survey of non-specialist dental practitioners was conducted between May and July 2019. Ethical approval was obtained from the University's Human Ethics Committee (approval number D19/107). A simple random sample of 800 general dental practitioners was selected from the 2019 Dental Council of New Zealand (DCNZ) Register. The chosen sample size was based on that used in a previous survey of GDPs in New Zealand (NZ) (Murray et al. 2016). The sample was drawn using the random sampling function in the Statistical Package for the Social Sciences (SPSS). Inclusion criteria included having an Annual Practising Certificate, being registered in only the General Dental Practice scope, and having

an email address. Participants included dental practitioners practising in major cities (Auckland, Wellington, Christchurch), provincial cities (such as Napier, Nelson and Palmerston North) and towns within New Zealand.

The present study was an “omnibus” survey. An omnibus survey is a method of quantitative marketing research where data on a wide variety of subjects is collected during the same interview (also known as a “piggyback” survey).¹ Along with a number of other questions that are not relevant to this report, nine questions were included in order to understand NZ GDPs’ knowledge of the selection and clinical application of dental adhesives. The survey used the Qualtrics platform, with a link sent to the DCNZ-recorded email address of each dentist selected. Implied consent was obtained automatically when the participant entered the link and responded to the survey. The first email out was sent on 3 May, followed by two further contacts for non-responders, after 3 and 6 weeks. Participation incentives were offered in the form of two random draws for a supermarket voucher for those who completed the survey.

Data were analysed using SPSS using cross-tabulations and Chi-square tests. The level of significance was set at $p < 0.05$.

Results

Of the 800 dentists contacted, 53 had nonvalid email addresses and “bounced” immediately, leaving 747. Of those, 217 responded to the survey, giving a response rate of 29%. There was no difference in the gender distribution between responders and non-responders. In both groups, 64% were males while 36% were females. On average, the responding sample had been in practice for longer than the non-responders (24 and 20 years, respectively).

Table 1 summarises the characteristics of the responding dentists by practice type. Only 20% of the

responding dentists were working in either corporate-owned or institutional practice. Nearly 60% of the respondents were within 30 years since graduation, and more than half were practising in major cities.

Data on dentists’ criteria for choosing a dental adhesive system are presented in Table 2. Fewer than a quarter of the respondents mentioned cost as a criterion in selecting a dental adhesive system, while the remaining respondents chose adhesives based on either the number of steps required for the application or the manufacturer or both. The practitioners from major cities predominantly chose dental adhesives based on the manufacturer.

Data on the practitioners’ use of manufacturers’ recommendations while applying adhesives are presented in Table 3. Nearly one-third reported not following the manufacturer’s recommendations. Of those, the majority were more recent graduates or working in conventional dental practice.

Data on awareness of the effect of improper handling and storage of adhesives on clinical performance are shown in Table 4. Almost all of the dentists were aware of the fact that the inappropriate handling and storage of an adhesive will affect its clinical performance. This was more apparent among the dentists with longer clinical experience.

Data on the use of selective etching for enamel when using self-etch adhesives for bonding are presented in Table 5. Approximately half of the dentists reported always using selective etching of enamel, but nearly one-third do it only sometimes.

Almost 90% of dentists reported performing an extra oral equipment check on their triplex for any water leaks before blow-drying the primer (Table 6).

Discussion

The survey questions were generated to provide a better understanding of the selection and clinical application of dental adhesives by GDPs because adhesive dentistry is an essential applied dental materials science in their everyday practice. Dental practitioners are confronted

1 <https://www.surveyanalytics.com/omnibus-survey-definition.html>

Table 1. Gender, years since graduation and practice location of the dentists, by practice type (brackets contain row percentages unless otherwise indicated)

		Practice type					
		Conventional		Corporate-owned		Institutional	
Gender	Male	117	(85.5)*	15	(10.9)	5	(3.6)
	Female	56	(70.9)	12	(15.2)	11	(13.9)
Years since graduation	Up to 10	44	(78.6)	4	(7.1)	8	(14.3)
	11-20	24	(77.4)	3	(9.7)	4	(12.9)
	21-30	37	(82.3)	6	(13.3)	2	(4.4)
	31+	69	(81.2)	14	(16.4)	2	(2.4)
Practice Location	Major city	93	(78.8)	15	(12.7)	10	(8.5)
	Provincial city	48	(78.7)	9	(14.8)	4	(6.5)
	Town	33	(86.8)	3	(7.9)	2	(5.3)
Total		174	(80.2)	27	(12.4)	16	(7.4)

* $P < 0.05$



Table 2. Criteria in choosing dental adhesive system, by practitioner characteristics (brackets contain row percentages)

		Cost	Number of steps required for its application	Manufacturing company
Gender	Male	27 (14.8)	68 (37.4)	87 (47.8)
	Female	22 (20.4)	45 (41.7)	41 (37.9)
Years since graduation	Up to 10	24 (27.9)*	33 (38.4)	29 (33.7)
	11-20	7 (16.6)	13 (31.0)	22 (52.4)
	21-30	6 (10.8)	25 (44.6)	25 (44.6)
	31+	12 (11.3)	42 (39.6)	52 (49.1)
Practice Location	Major city	22 (13.6)	61 (37.7)	79 (48.7)*
	Provincial city	14 (18.6)	32 (42.7)	29 (38.7)
	Town	13 (24.1)	20 (37.1)	21 (38.8)
Practice type	Conventional	41 (17.2)	91 (38.4)	105 (44.4)
	Corporate-owned	4 (12.5)	13 (40.7)	15 (46.8)
	Institutional	4 (19.0)	9 (43.0)	8 (38.0)
Total		49 (16.9)	113 (38.9)	128 (44.2)

* P<0.05

Table 3. Follow manufacturer's recommendation when using an adhesive system, by practitioner characteristics (brackets contain row percentages)

		Yes	No	P-value
Gender	Male	99 (71.7)	39 (28.3)	0.07 [§]
	Female	47 (59.5)	32 (40.5)	
Years since graduation	Up to 10	28 (50.0)	28 (50.0)	0.01*
	11-20	22 (71.0)	9 (29.0)	
	21-30	31 (68.9)	14 (31.1)	
	31+	65 (76.5)	20 (23.5)	
Practice location	Major City	77 (65.3)	41 (34.7)	0.43
	Provincial City	41 (66.1)	21 (33.9)	
	Town	29 (76.3)	9 (23.7)	
Practice Type	Conventional	121 (69.5)	53 (30.5)	0.03*
	Corporate-owned	19 (70.4)	8 (29.6)	
	Institutional	6 (37.5)	10 (62.5)	
Total		146 (67.3)	71 (32.7)	

[§] Fisher's Exact test; * P<0.05

Table 4. Awareness about the effect of improper handling and storage of adhesives on its clinical performance, by practitioner characteristics (brackets contain row percentages)

		Yes	No	P-value
Gender	Male	127 (96.2)	5 (3.8)	0.55
	Female	68 (94.4)	4 (5.6)	
Years since graduation	Up to 10	44 (89.8)	5 (10.2)	0.11
	11-20	31 (100.0)	0 (0.0)	
	21-30	43 (97.7)	1 (2.3)	
	31+	77 (96.3)	3 (3.7)	
Practice location	Major City	103 (95.4)	5 (4.6)	0.85
	Provincial City	57 (95.0)	3 (5.0)	
	Town	36 (97.3)	1 (2.7)	
Practice type	Conventional	158 (95.8)	7 (4.2)	0.87
	Corporate-owned	24 (96.0)	1 (4.0)	
	Institutional	13 (92.9)	1 (7.1)	
Total		195 (95.6)	9 (4.4)	

*P<0.05

Table 5. Selective etching performed when using self-etch adhesives for bonding, by practitioner characteristics (brackets contain row percentages)

		Yes, always	Yes, sometimes	No	P-value
Gender	Male	77 (57.9)	34 (25.6)	22 (16.5)	0.41
	Female	39 (51.3)	26 (34.2)	11 (14.5)	
Years since graduation	Up to 10	31 (55.4)	13 (23.2)	12 (21.4)	0.16
	11-20	21 (67.7)	7 (22.6)	3 (9.7)	
	21-30	20 (48.8)	11 (26.8)	10 (24.4)	
	31+	44 (54.3)	29 (35.8)	8 (9.9)	
Practice location	Major City	61 (53.0)	34 (29.6)	20 (17.4)	0.67
	Provincial City	36 (61.0)	17 (28.8)	6 (10.2)	
	Town	20 (55.6)	9 (25.0)	7 (19.4)	
Practice Type	Conventional	93 (55.7)	47 (28.1)	27 (16.2)	0.78
	Corporate-owned	13 (48.2)	10 (37.0)	4 (14.8)	
	Institutional	10 (66.7)	3 (20.0)	2 (13.3)	
Total		116 (55.5)	60 (28.7)	33 (15.8)	

*P<0.05

Table 6. 3-way syringe (triplex) checked for any water leak before blow-dry the primer, by practitioner characteristics (brackets contain row percentages)

		Always	Usually	Sometimes	Never	P-value
Sex	Male	95 (68.8)	28 (20.3)	14 (10.2)	1 (0.7)	0.91
	Female	55 (70.5)	16 (20.5)	6 (7.7)	1 (1.3)	
Years since graduation	Up to 10	38 (69.1)	12 (21.8)	3 (5.5)	2 (3.6)	0.07
	11-20	25 (80.6)	6 (19.4)	0 (0.0)	0 (0.0)	
	21-30	34 (75.6)	5 (11.1)	6 (13.3)	0 (0.0)	
	31+	53 (62.4)	21 (24.7)	11 (12.9)	0 (0.0)	
Practice location	Major City	83 (70.9)	19 (16.3)	13 (11.1)	2 (1.7)	0.55
	Provincial City	43 (69.3)	15 (24.2)	4 (6.5)	0 (0.0)	
	Town	25 (65.8)	10 (26.3)	3 (7.9)	0 (0.0)	
Practice Type	Conventional	123 (71.1)	32 (18.5)	16 (9.2)	2 (1.2)	0.53
	Corporate-owned	18 (66.7)	8 (29.6)	1 (3.7)	0 (0.0)	
	Institutional	9 (56.3)	4 (25.0)	3 (18.7)	0 (0.0)	
Total		150 (69.4)	44 (20.4)	20 (9.3)	2 (0.9)	

*P<0.05

by the need to select an appropriate dental adhesive from a wide range of available options. While cost was a determining factor for some participants, most reported selecting dental adhesives based on either the number of steps required for the application and/or the manufacturer. Almost all participants are aware of the importance of proper handling and storage of dental adhesives. However, nearly one-third did not follow the manufacturer's recommendations.

This study used a questionnaire-based survey of registered general dentists in NZ. Questionnaires can be very useful to gather data from the study population in a short period of time and in a relatively cost-effective way. However, the validity of the study relies on information from the respondents and response rates from the survey. In the present survey, two further contacts were sent to non-responders after 3 and 6 weeks in addition to incentives offered to improve the response rate. Despite these efforts, the study had a lower response rate (29%) than other surveys of dentists (Jacobsen

and Söderholm 1995; Lamb 2019). The reasons for different response rates vary, but they may include the interests of clinicians, the use of an online survey, and the number and type of questions being asked, given that the questions on adhesives comprised part of a wide-ranging omnibus survey.

A good understanding of material sciences and science of adhesion—coupled with proper use of the chosen adhesive—are required to achieve an optimal treatment outcome. The present study has shown that most dentists select their dental adhesives based on the number of steps required for the clinical application. The latest trend in adhesive technology is to simplify the bonding procedure by reducing the number of steps required. It is essential for dentists to understand that, although simplified dental adhesive systems offer convenience in clinical use, they might require a trade-off against longer-term clinical effectiveness (Peumans et al. 2014; Perdigão 2020). The simplified two-step etch-and-rinse and one-step self-etch adhesives have been



developed to combine the primer and the adhesive resin into a single application. However, research evidence has shown that this simplified adhesive system tends to perform less effectively than the 3-step etch-and-rinse adhesive system (Peumans et al. 2014). Three-step etch-and-rinse and two-step self-etch adhesive systems are still considered the most durable dental adhesive systems. The application of a hydrophobic adhesive resin in an independent step translates to higher bond strength and hydrolytically creates a more stable interface than simpler adhesive systems (two-step etch-and-rinse or one-step self-etch adhesives) that involves a mixture of both hydrophobic and hydrophilic components (Tezvergil-Mutluay et al. 2015).

The clinical application protocol for a dental adhesive system (based on the manufacturer's recommendations) is a critical factor for achieving successful adhesion. Many of the common errors that were observed in dentists' reported adhesion practices arose from lack of understanding of the products used or not following the manufacturers' recommendations. A question was incorporated in the present survey to investigate the dentists' attitudes in this aspect. Nearly one-third of the respondents do not follow the manufacturer's recommendations when using an adhesive system. This is concerning, because failure to follow the manufacturers' recommended application protocol could affect the adhesion and compromise the clinical outcome (Yoshida et al. 2004).

Selective enamel etching with 37% phosphoric acid prior to the application of self-etch adhesives improves bonding performance (Szesz et al. 2016; Sato et al. 2018). It has been shown to decrease the chance of marginal defects (Ekambaram et al. 2015) and is considered to be less aggressive towards dentine, thereby reducing the chance of postoperative sensitivity (Peumans et al. 2010). The present survey showed that nearly half of the responding dentists did not perform selective enamel etching (or did it only sometimes).

There are other less-known factors that could also affect the performance of dental adhesive systems. One of them is the storage and handling of the adhesive container, which can affect the solvent content

(Ekambaram et al. 2015). Shibuya-Chiba et al. (2010) also reported that bond strength would be degraded if the dental adhesives are stored at 40°C. It is essential to store the adhesives container at a lower temperature and use it before its expiry date (Chang et al. 2009). The wider range of choices of different dental adhesives creates uncertainty among clinicians about which type to use and its handling in daily work for a specific clinical situation.

A recent study showed that contamination with water, saliva, and blood during a dental bonding procedure will reduce adhesive bond strength (Prasad et al. 2014). Air from the triplex syringe is routinely used to dry the adhesive primer, when its use is indicated. However, the expelled air from the triplex syringe could have moisture contamination due to water leakage, leading to compromised adhesion (Jacobsen and Söderholm 1995; Mante et al. 2013). Thus, we asked survey respondents whether they check their triplex for any water leak before blow-drying the primer. It was reassuring to find that most did so.

Future research is needed to determine the type of isolation (dental dam, cotton rolls, buccal pads) routinely used by clinicians when placing restorations and whether the choice of dental adhesives and clinical protocols differs between GDPs and specialists. Many dentists may also use different brands of dental adhesives to composite resin restorative materials although this is not recommended by manufacturers. The rate and reason for doing so needs to be explored as well.

Conclusions

Only one-quarter of the respondents mentioned cost as a criterion in selecting a dental adhesive system. Nearly one-third of the respondents reported not following the manufacturer's recommendations when using an adhesive system, and nearly half did not undertake selective enamel etching (or did it only sometimes). Almost all respondents were aware of the fact that the inappropriate handling and storage of an adhesive will affect its clinical performance, and 90% reported performing a check on their triplex for any water leaks before blow-drying the primer.

Author details

Fatma Al-Kindi BDS

Rawan Al-Harrasi BDS

Haritha Coimbatore BDS

Shafiq Aziz BDS

William Murray Thomson BSc, BDS, MComDent, MA, PhD

Manikandan Ekambaram BDS, MDS, PhD Corresponding author mani.ekambaram@otago.ac.nz

Department of Oral Sciences, Sir John Walsh Research Institute, University of Otago, Dunedin, New Zealand

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