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Factors that influence the knowledge profile of Brazilian dental professionals about dental adhesive systems

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Abstract Dental adhesive systems are directly involved in common procedures of clinical dentistry, which makes knowledge about this topic indispensable for professionals. The objectives of the current study are to analyze the knowledge profile of dental professionals about dental adhesive systems and verify factors that influence this closure, with emphasis on professional education. The data was collected using a list of questions that consider: I) Professional profile and II) Knowledge, use, and preferences of adhesive systems. The sample considers 501 Brazilian dentists and the data was analyzed using the software Sigma Stat 5.0 ($p<0.05$). The minimum percentual of correct questions considered adequate was defined as 80%. The results show that only 46.3% of the professionals demonstrated satisfactory knowledge on the subject. In addition, it verified relevant statistical association between low level of correct questions and professionals with preferences for simplified adhesive systems ($p=0.046$), orthodontic specialists [OR=0.24 (0.08–0.67)], and dentists with private education degrees [OR=1.58 (1.03–2.42)]. This context indicates the imminent necessity to resolve this weakness through improvements in the educational curriculum, as well as continuing education of faculty and constant updating of professionals.
Descriptors: Education, Dental. Evidence-Based Dentistry. Dentin-Bonding Agents.

Factores que influyen en el perfil de conocimiento de los odontólogos brasileños sobre los sistemas adhesivos

Resumen Los sistemas adhesivos están directamente involucrados en los procedimientos más comunes de la práctica clínica dental, lo que hace que su conocimiento sea fundamental para los profesionales. El objetivo del presente estudio fue evaluar el perfil de conocimiento sobre sistemas adhesivos y verificar los factores que influyen en ese resultado, con énfasis en la formación profesional. La recolección de datos se realizó a través de un cuestionario teniendo en cuenta: I. Perfil del profesional; II. Conocimiento, uso y preferencias sobre los sistemas adhesivos. La muestra estuvo compuesta por 501 dentistas brasileños y los datos fueron analizados mediante el programa Sigma Stat 5.0 ($p<0,05$). El porcentaje mínimo de respuestas correctas a las preguntas considerado adecuado se definió en el 80%. Los resultados mostraron que sólo el 46,3% de los profesionales demostraron conocimientos adecuados sobre el tema. Además, hubo una asociación estadísticamente significativa entre el bajo nivel de aciertos y los profesionales con preferencia por los sistemas adhesivos simplificados ($p=0,046$), especialistas en ortodoncia [OR=0,24 (0,08-0,67)] y odontólogos egresados de instituciones privadas [OR=1,58 (1,03-2,42)]. Este escenario advierte de la inminente necesidad de subsanar esta debilidad a través de mejoras en las matrices curriculares, además de la formación continua de los docentes y la constante actualización de los profesionales.
Descriptores: Educación en Odontología. Odontología Basada en la Evidencia. Recubrimientos Dentinarios.

Fatores que influenciam o perfil de conhecimento dos cirurgiões-dentistas brasileiros sobre sistemas adesivos

Resumo Os sistemas adesivos estão diretamente envolvidos nos procedimentos mais corriqueiros da prática clínica odontológica, o que torna o seu conhecimento indispensável para os profissionais. O objetivo do presente estudo foi avaliar o perfil de conhecimento sobre sistemas adesivos e verificar os fatores que influenciam nesse desfecho, com ênfase na formação profissional. A coleta de dados foi realizada por meio de um questionário

levando em consideração: I. Perfil do profissional; II. Conhecimento, uso e preferências sobre os sistemas adesivos. A amostra foi composta por 501 cirurgiões-dentistas brasileiros e os dados foram analisados no programa Sigma Stat 5.0 ($p<0,05$). O percentual mínimo de acertos das questões considerado adequado foi definido como 80%. Os resultados mostraram que apenas 46,3% dos profissionais demonstraram conhecimento adequado sobre o assunto. Além disso, verificou-se associação estatisticamente significativa entre o baixo nível de acertos e profissionais com preferência por sistemas adesivos simplificados ($p=0,046$), especialistas em ortodontia [OR=0,24 (0,08-0,67)] e cirurgiões-dentistas graduados em instituições privadas [OR=1,58 (1,03-2,42)]. Esse cenário alerta para a necessidade iminente de sanar essa fragilidade por meio de melhorias nas matrizes curriculares, além da educação continuada de docentes e constante atualização dos profissionais.
Descritores: Educação em Odontologia. Odontologia Baseada em Evidências. Adesivos Dentinários.

INTRODUCTION

Dental restoration is one of the most common procedures in clinical practice, as it is the most common dental need of patients[1-4]. Thus, knowledge about restorative materials and their application techniques is extremely important to meet this demand with satisfactory results.

Dental-bonding has changed significantly in recent decades, and composite resins have become the material most employed for direct restorations[5], although they have considerable failure rates that can result in the need for repair or replacement[4,6-10].

These materials are extremely sensitive to technique, and their success depends on the careful execution of each operative step[11,12]. One of the factors related to failure is the incorrect application of adhesive systems, which can lead to clinical situations, such as postoperative sensitivity, marginal pigmentation, loss of retention, and recurring caries[13,14].

Information about dental materials is a mandatory part of dental school curriculum. The development of skills, abilities, and attitudes related to the use of dental adhesive systems must be achieved by the end of clinical courses. However, due to frequent innovations and the variety of commercial options, academics and professionals often find it difficult to select and apply these materials, which can lead to errors in the technique and consequently biological and financial losses[16]. Studies employing questionnaires have found a lack of knowledge and uniformity in bonding protocols[17-21]. To solve this problem, continuing education activities are an important option for updating and qualifying professionals[22].

To plan these educational activities, a greater understanding of how materials are applied and the main knowledge gaps are important to build strategies that reduce weaknesses and help improve the quality of restorations. Therefore, this study aimed to evaluate the knowledge profile of Brazilian dental professionals about adhesive systems and to determine the factors that influence this, with emphasis on professional training.

METHODS

Study design

This is an observational epidemiological study, in which the researcher is only an observer and does not perform any type of intervention on the sample[23]. The study employed a cross-sectional and quantitative approach, using an electronic questionnaire as an instrument, and the project was approved by the Research Ethics Committee of the Universidade Federal do Ceará, under opinion number 4,346,184 (CAAE: 37156320.6.0000.5054). The beginning of the document contained a Free Informed Consent Form, and only those who agreed with the methodology of the study continued with the questionnaire.

Questionnaire development and pretesting

The questionnaire was developed by a team with experience in restorative dentistry and addressed the main questions, based on their teaching and clinical experience, about adhesive systems. The questionnaire was on the Google® Forms platform (Google, Mountain View, CA, USA), with only one completion allowed per registered e-mail.

Prior to beginning the study, a pretest was conducted of the questionnaire with 20 professionals not involved in the sample to verify the clarity of the questions, and the necessary adjustments were made based on the considerations obtained. Some distance parameters, such as "close to the cavity" and "far away from the cavity," were defined better with the inclusion of terms that are easier for clinicians to understand. In general, the questionnaire was well structured and approved by the pretest participants, with only minor caveats, such as the one mentioned above.

Sample selection and sample calculation

Assuming an unknown number, an unknown prevalence of 50% variables of interest, 5% margin of error, and 95% confidence interval were considered, it was estimated the need for at least 384 professionals to participate in the study.

Application of the questionnaire and collection of responses

The questionnaire contained 21 objective questions and their content was divided into two parts: I. Professional's profile (gender, age, professional status, type of institution they graduated from, time since graduation, highest academic degree, and main place of service); II. Knowledge, use, and preferences of adhesive systems (application technique for etch-and-rinse and self-etch systems; preferred commercial presentation, safety of application technique, and means of obtaining scientific evidence).

The invitation to participate in the study was sent by messaging application and social networks (WhatsApp®, Instagram®, and Facebook®) to dentists in professional practice throughout Brazil.

Statistical analysis

The collected results were tabulated, and the alternatives of each question were classified as correct/acceptable or incorrect to determine the percentage of correct answers. Data were exported to the Statistical Package for Social Sciences (SPSS) v. 20 (IBM, Armonk, NY, USA) and analyzed adopting a 95% confidence level. The absolute and percentage frequencies of each participant's response and the percentage of correct answers were calculated. After categorization, the percentage of correct answers based on an 80% cutoff point, as suggested in previous studies[24-26], was associated with the other categories (specialty, professional preferences, among others) employing Fisher's exact test or Pearson's chi-square test. Data showing $p<0.200$ were submitted to the multinomial logistic regression model.

RESULTS

A total of 501 professionals participated in the survey, of these 72.5% were female, 52.9% were between 20 and 29 years old, 69.3% had graduated in the last 5 years, and 62.1% had graduated from a private institution. Most of the participants stated that they work mainly in the private sector (76.7%), and 42.9% had only an undergraduate degree. The majority of the responses came from the Southeast (41.7%), followed by the Northeast (23.7%), South (17.2%), Central-West (9.8%), and North (7.6%).

Of these professionals, 53.9% prefer simplified adhesive systems. Most respondents felt confident (72.5%) or partially confident (24.9%) about the application technique, while only 13 (2.6%) of the respondents reported not feeling confident in using these materials. The most common method of updating their knowledge on the subject was the internet (71.3%), followed by recommendations from professional colleagues and/or professors (62.3%), articles in

scientific journals (58.1%), lectures at scientific events (57.9%), books (32.9%), and magazines provided by the dental materials industries (15.2%).

Data on correct and incorrect answers were expressed as absolute and percentage frequency. According to Table 1, the average correct rate was 65.3±17.0% of the items, ranging from 27.3 to 100.0% of the 11 questions evaluated. Of the 501 respondents, only 232 (46.3%) demonstrated a performance level of 80% or higher on the items.

When comparing the correct answers to the profile of the professionals, a statistically significant association was found between the level of knowledge and the following variables: preferred bonding systems (Table 2), dental specialty (Tables 2 and 3), and undergraduate dental school (Table 3).

Based on a percentage of correct answers for 80% of the questions, the success rate tended to increase for specialists in restorative dentistry and prosthodontics, while the error rate tended to increase for specialists in orthodontics. Graduation from public institutions resulted in a 1.58-fold increase in the prevalence of correct answers, and the error rate tended to increase for professionals opting for simplified bonding systems.

DISCUSSION

The evaluation of the professionals' knowledge profile was made based on their correct answers. For this, an average of 80% correct answers was considered the parameter to determine the adequate minimum level of knowledge on the subject, according to previous studies[24-26], which was reached by only 46.3% of the professionals. Although 80% seems high, it can be considered minimally adequate because these materials are used in the vast majority of restorative procedures, which is the most common procedure in clinical dentistry.

It is concerning that more than half of the respondents did not have adequate knowledge about application of dental adhesives, since restorative dentistry procedures, which in most cases involve these materials, are basic knowledge of a generalist professional and one of the most common procedures in dental practice[1-4]. Studies with similar methodologies conducted in Brazil, Denmark, Iran, Saudi Arabia, and Palestine also found a low level of correct answers regarding knowledge and use of these materials[17-21].

To the best of our knowledge, the present study is the first to evaluate the precision of Brazilian dentist-surgeons based on an adequate minimum score of 80% and to identify the main factors related to their degree of knowledge on the subject. A statistically significant association was found between low rates of correct answers (< 80%) and professionals with a preference for simplified adhesive systems, orthodontics specialists, and dentists who graduated from private institutions.

Professionals who preferred more simple bonding systems tended to have more incorrect responses, i.e., professionals who seek greater practicality and speed in their restorative procedures. By focusing on reducing clinical time, they may end up not respecting the basic criteria for the correct execution of each step, which would result in a longer office time, making them more prone to errors.

Specialists in Restorative Dentistry and Prosthodontics performed better on the survey. In fact, the aforementioned specializations present content that includes updated and deep theoretical and practical information on restorative materials and their application techniques, including dental adhesive systems. Thus, both specialties have significantly better knowledge of these materials. On the other hand, the prevalence of correct answers was lower for orthodontic specialists. This result could be related to the fact that this specialty does not work directly in restorative dentistry, performing bonding only to install brackets, i.e., the application of adhesive systems is performed exclusively on dental enamel, which does not involve the issues arising from dentin-bonding presented in this study.

Graduating from a public institution resulted in a 1.58-fold increase in the prevalence of at least 80% correct answers. The National Student Performance Exam (ENADE), applied in 2019, evaluated 238 undergraduate dental courses, 58

Table 1. Absolute frequency and percentage of responses about the application technique.

Variable	n	%
1. Time for acid etching on enamel		
Up to 10 s	10	2
*15 s	105	21
*20 s	63	12.6
*30 s	306	61.1
1 min	8	1.6
There is no exact duration.	9	1.8
2. Time for acid etching on dentin		
Up to 10 s	104	21.3
*15 s	332	67.9
20 s or more	53	10.8
3. Rinse time after acid etching		
10 s	83	16.6
*15 s	77	15.4
*30 s	174	34.7
*1 min	111	22.2
There is no exact duration.	56	11.2
4. Technique for drying the etched dentin		
Strong dry air jet far away from the cavity (≅ 22 cm)	35	7.2
Strong dry air jet close to the cavity (≅ 5 cm)	41	8.4
Gletle dry air jet far away from the cavity (≅ 22 cm)	93	19.1
Gletle dry air jet close to the cavity (≅ 5 cm)	146	29.9
*Absorbent paper	80	16.4
*Cotton	88	18
Other	5	1
5. Application of acid etching to a self-etch system		
*Do not apply acid etching	151	30.1
Apply only on dentin	6	1.2
*Apply only on enamel	239	47.7
Apply on enamel and dentin	105	21
6. Primer/bonding applicator	*501*	
**Microbrush*	494	98.6
Other	7	1.4
7. Application technique for the primer		
*Actively, by vigorous rubbing	277	55.3
Actively, by gently rubbing	164	32.7
Passively, without rubbing	60	12
8. Number of layers (2-step etch-and-rinse)		
1 layer	193	38.5
*2 layers	292	58.5
I use another type of bonding	15	3
9. Number of layers and photopolymerization technique (2-step etch-and-rinse)		
1 layer; photopolymerization	59	11.8
1 layer; dry air jet; photopolymerization	137	27.3
2 layers; photopolymerization on each layer	26	5.2
2 layers; dry air jet before the second layer; photopolymerization on each layer	49	9.8
2 layers; dry air jet before the second layer; photopolymerization of both layers together	81	16.2
*2 layers; dry air jet before each layer; photopolymerization of both layers together	130	25.9
I use another type of bonding	19	3.8
10. Distance from the photopolymerizer		
*Touching into the cavity (0 mm)	219	43.7
Near the cavity (up to 5 mm)	264	52.7
Far from the cavity (more than 5 mm)	18	3.6
11. Photopolymerization time	*501*	
Less than 10 s	11	2.2
*10 s	60	12
*20 s	325	64.9
*40 s	105	21
Correct answers		
1. Time for acid etching on enamel	474	94.6
2. Time for acid etching on dentin	333	66.5
3. Rinse time after acid etching	361	72.1
4. Technique for drying the etched dentin	256	51.1
5. Application of acid etching in a self-conditioning system	388	77.4
6. Primer/bonding applicator	494	98.6
7. Application technique for the primer	163	32.5
8. Number of layers (2-step etch-and-rinse)	292	58.3
9. Number of layers and photopolymerization technique (2-step etch-and-rinse)	130	25.9
10. Distance from the photopolymerizer	219	43.7
11. Photopolymerization time	490	97.8

*Answers considered correct/acceptable

Table 2. Association between correct answers and type of adhesive system/dental specialty.

Variable	Total	Percent of correct responses <80%	≥80%	p-value
Does the number of steps influence your choice of adhesive systems?				
Yes, I prefer the simpler ones.	270 (53.9%)	213 (56.6%)*	57 (45.6%)	0.046
Yes, I prefer the less simple ones.	26 (5.2%)	19 (5.1%)	7 (5.6%)	
No, the number of steps does not influence my choice.	179 (35.7%)	122 (32.4%)	57 (45.6%)*	
I prefer not to respond.	26 (5.2%)	22 (5.9%)	4 (3.2%)	
Do you have a specialization certificate?				
Yes	272 (54.3%)	199 (52.9%)	73 (58.4%)	0.287
Restorative Dentistry	40 (8.0%)	24 (6.4%)	16 (12.8%)*	0.022
Endodontics	55 (11.0%)	45 (12.0%)	10 (8.0%)	0.219
Implantology	40 (8.0%)	32 (8.5%)	8 (6.4%)	0.451
Pediatric Dentistry	14 (2.8%)	12 (3.2%)	2 (1.6%)	0.350
Orthodontics	56 (11.2%)	52 (13.8%)*	4 (3.2%)	0.001
Periodontology	22 (4.4%)	17 (4.5%)	5 (4.0%)	0.805
Prosthodontics	34 (6.8%)	20 (5.3%)	14 (11.2%)*	0.024
Others	55 (11.0%)	47 (12.5%)	8 (6.4%)	0.059

*p<0.05, Fisher's exact test or Pearson's chi-square test (n, %).

Table 3. Multivariate analysis of determinants for a high rate of knowledge about bonding systems.

	p-value	Adjusted OR (CI95%)
≥*80% correct*		
Undergraduate institution (public vs. private)	*0.036	1.58 (1.03-2.42)
Specialization in Restorative Dentistry (yes vs. no)	0.101	1.79 (0.89-3.58)
Specialization in Orthodontics (yes vs. no)	*0.007	0.24 (0.08-0.67)
Specialization in Prosthodontics (yes vs. no)	0.144	1.75 (0.83-3.70)
Specialization in Other areas (yes vs. no)	0.117	0.53 (0.24-1.17)

*p<0.05, multinomial logistic regression

of which were public, 178 private, and 2 with a special administrative category. The results showed that among the 16 best evaluated dental schools in the country, with the highest score on the exam, 75% are public (federal or state)[27].

Regardless of the type of institution, public or private, the main objective of a dental school should be to form good generalists with theoretical and practical mastery of materials and techniques, as well as other general and specific skills. With the increase in the number of dental schools in Brazil, there has been an increase in the number of professionals in the country, which currently results in a high ratio of dentists per inhabitant, greater than 1:1,500 in all regions[28].

Even in a highly saturated job market, many institutions continue to offer courses and sometimes graduate dentists without the desired skills[29]. The nature of the institutions ends up defining their strategic vision and these, according to their purposes, often encourage adaptations in the system that can directly influence the quality of education. The reduction in the number of hours and professors to minimum parameters, the decrease in the proportion of practice/theory, the increase in the number of students per class , and the reduction in the number of doctors and masters on the teaching staff can negatively influence the quality of the graduates, not only in the restorative area, but in dentistry as a whole.

In 2019, the Brazilian Ministry of Education (MEC) authorized, through Ordinance No. 2.117[30], the possibility of distance education (EaD) for up to 40% of the total courseload of face-to-face courses in the health areas. Private institutions are the ones that offer the most distance education. Although this can provide accessibility and reduce costs, it can lead to future losses in academic performance if the resource is used in too high a proportion[32-34]. A recent study showed that dental students with more distance education classes had low academic performance in the Enade[34] exam, which shows that this model still needs many adaptations to guarantee the same quality as face-to-face teaching[35].

Based on the results of this study, although 72.5% of the professionals feel confident about the application of bonding systems, 53.7% did not have the minimum level of adequate knowledge defined in this study (80% or more), which can be considered a significant number. These data demonstrate that this topic should be reinforced in undergraduate courses, with more study in both in laboratory and clinical practices, to change the current scenario.

As the stages of the course progress, students often focus on more complex dental procedures. However, unresolved questions and difficulties related to basic procedures, such as the use of bondings, can lead to errors in professional practice. The consequences of the incorrect application of these materials should always be kept in mind and be a goal, pointing to the need for adherence to established protocols and constant updating, based on current scientific evidence.

According to data from the Conselho Federal de Odontologia (CFO)[36], Brazilian dentists are geographically distributed in the following order: Southeast (52.6%), Northeast (16.7%), South (16.2%), Midwest (8.72%), and North (5.5%). In the present study, the professionals were distributed similarly and in the same order, with the following percentages: 41.7%, 23.7%, 17.2%, 9.8%, and 7.6%, respectively. Thus, although this study was conducted with a convenience sample, because only people who electronically accessed the invitation could participate, the geographical distribution of the professionals indicates some representativeness of the sample. Respondents included a considerably larger number of young participants probably because this is the public that uses virtual platforms most; thus, the sample cannot be considered random.

Despite these limitations, the study warns of the imminent need to correct this weakness by improving the curriculum with special attention to this topic, as well as the continuing education of professors and dentists who work in the area. To help the participants and with the goal of disseminating knowledge based on scientific evidence, reading material was made available via e-mail with the questions answered and explained in detail, as well as bibliography to keep them up to date on the subject.

CONCLUSION

Knowledge gaps on the subject could be identify, as only 46.3% of the dental professional surveyed reached the minimum percentage of correct answers considered adequate in this study. Factors that negatively influenced the rate of correct responses were related to the type of bonding system selected, the dental specialty, and the type of institution the professionals graduated from.

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