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Is the teaching of amalgam in dental training still necessary? The perception of dental surgeons

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Abstract Dentistry has recently experienced a sharp decline in the use of amalgam, as a result of the evolution of adhesive materials and techniques and discussions about the risks of mercury contamination. Thus, we sought to identify the perception of dentists about the need to continue teaching amalgam in dentistry courses. This is a cross-sectional study, using a semi-structured questionnaire with aspects related to sociodemographic conditions, training to perform the procedures, knowledge about material management and waste management. The objective responses were analyzed by descriptive statistics and the subjective ones processed in the IRaMuTeQ software. Of the 257 respondents, 60.7% claim to use this material, 91.8% use encapsulated amalgam and 95.7% dispose of waste in hospital waste. Regarding the permanence of the material, 63.4% believe it is necessary and 88% agree that teaching should continue, especially considering the profile of the graduate suggested by the National Curriculum Guidelines. From the subjective data emerged five classes/categories that portray the perception of professionals about cost-benefit ratio, access to service, working conditions and longevity of restorations. It is concluded that, even with the evolution of adhesive materials, amalgam is still necessary, especially in the public service, where the demand for low cost and high longevity restorations is high. Thus, for this sample, as long as there is no mercury-free, inexpensive, easy to handle and durable restorative material, the teaching of this content should remain in undergraduate courses in Dentistry.
Descriptors: Dental Amalgam. Education, Dental. Dentistry, Operative.

¿Sigue siendo necesaria la enseñanza de la amalgama en la carrera odontológica? Percepción de los dentistas

Resumen La odontología ha experimentado recientemente una fuerte disminución en el uso de amalgamas como resultado de las discusiones sobre los riesgos de contaminación por mercurio, así como la evolución de los materiales y las técnicas adhesivas. Así, buscamos identificar la percepción de los odontólogos sobre la necesidad de continuar enseñando amalgama en los cursos de odontología. Se trata de un estudio transversal utilizando un cuestionario semiestructurado con aspectos relacionados con las condiciones sociodemográficas, capacitación para realizar los procedimientos, conocimientos sobre manejo de materiales y gestión de residuos. Las respuestas objetivas se analizaron mediante estadística descriptiva y las respuestas subjetivas se procesaron mediante el software IRaMuTeQ. De los 257 encuestados, el 60,7% afirma utilizar este material, el 91,8% utiliza amalgama encapsulada y el 95,7% desecha los residuos en la basura de hospital. En cuanto a la permanencia del material, el 63,4% cree que es necesario y el 88% está de acuerdo en que la enseñanza debe continuar, sobre todo para la graduación de profesionales que van al servicio público. A partir de los datos subjetivos, surgieron cinco clases/categorías que retratan la percepción de los profesionales sobre la rentabilidad, el acceso al servicio, las condiciones de trabajo y la longevidad de las restauraciones. Se concluye que, aún con la evolución de los materiales adhesivos, la amalgama sigue siendo necesaria, especialmente en el servicio público, donde la demanda de restauraciones de bajo costo y gran longevidad es alta. Así, mientras no exista un material restaurador libre de mercurio, económico, fácil de manejar y duradero, la enseñanza de este contenido debe permanecer en los cursos de graduación en odontología.
Descriptores: Amalgama Dental. Educación en Odontología. Operatoria Dental.

O ensino do amálgama na formação odontológica ainda é necessário?

Percepção de cirurgiões-dentistas

Resumo A Odontologia tem vivenciado, nos últimos tempos, um declínio acentuado do uso do amálgama, em consequência da evolução dos materiais e técnicas adesivas e das discussões acerca dos riscos de contaminação pelo mercúrio. Assim, buscou-se identificar a percepção dos cirurgiões-dentistas sobre a necessidade da continuidade do ensino do amálgama nos cursos de Odontologia. Trata-se de um estudo transversal, usando um questionário semiestruturado com aspectos relativos às condições sociodemográficas, capacitação para executar os procedimentos, conhecimento acerca do manejo do material e gerenciamento dos resíduos. As respostas objetivas foram analisadas pela estatística descritiva e as subjetivas processadas no software IRaMuTeQ. Dos 257 respondentes, 60,7% afirmam utilizar esse material, 91,8% usam amálgama encapsulado e 95,7% descartam os resíduos em lixo hospitalar. Sobre a permanência do material, 63,4% acreditam ser necessária e 88% concordam que o ensino deva continuar sobretudo considerando o perfil do egresso sugerido pelas Diretrizes Curriculares Nacionais. Dos dados subjetivos emergiram cinco classes/categorias que retratam a percepção dos profissionais sobre relação custo-benefício, acesso ao serviço, condições de trabalho e longevidade das restaurações. Conclui-se que, mesmo com a evolução dos materiais adesivos, o amálgama ainda é necessário, principalmente no serviço público, onde a demanda por restaurações de baixo custo e grande longevidade é alta. Assim, para essa amostra, enquanto não houver um material restaurador livre de mercúrio, barato, de fácil manuseio e durável, o ensino desse conteúdo deve permanecer nos cursos de graduação em Odontologia.

Descritores: Amálgama Dentário. Educação em Odontologia. Dentística Operatória.

INTRODUCTION

Silver amalgam was the most widely used material in dentistry for the restoration of posterior teeth, with strong clinical and scientific evidence that supported its use throughout the twentieth century[1]. However, evolutions in the knowledge and treatment of dental caries towards a more conservative approach led to a paradigm shift, from the principles of extension for prevention proposed by Black to a conception of minimal intervention of the dental structure[2], which contributed to the reduction of the use of amalgam, since the material requires more defined cavity preparations with greater tooth wear.

Allied to this, the great demand for aesthetic procedures, together with the evolution of composite resins and adhesive systems observed in recent decades, made it possible to perform restorations increasingly close to the natural color of the tooth, with a satisfactory adhesion and greater preservation of the healthy dental structure[3]. Added to these facts is the controversy surrounding the toxicological safety of the amalgam, due to the presence of mercury in its composition[4].

In this context, discussions that arose after the Minamata disaster in Japan in 1956 led representatives of more than 140 countries in October 2013 to sign the "Minamata Convention", a document that established the deadline until 2020, so that there was the elimination of mercury in various materials such as thermometers, blood pressure meters, batteries, fluorescent lamps, among others. Regarding amalgam restorations, the treaty suggested provisions regarding the gradual reduction of its use, without measures aimed at total elimination, nor prohibition of the use of this material[5]. From then on, periodic meetings of this convention began to discuss in subsequent years the deepening of the issues raised.

In the third "Convention of the Parties" (COP 3) held in 2019, measures to gradually reduce the use of dental amalgam in Dentistry were included. At that time, the parties drafted a proposal for the so-called "phase-out", that is, for the gradual elimination of amalgam by 2024, except when there was no alternative available. Also in 2019, the International Association for Dental Research (IADR) meeting concluded that there is insufficient evidence to support a causal association between mercury from dental amalgam and adverse health effects in the general population. In parallel, IADR has committed to: 1) placing greater emphasis on research on primary prevention and behavior change strategies that will reduce the prevalence of tooth decay, and 2) promoting research on new dental materials that may one day fully replace amalgam[6].

In the current stage of this discussion, it was added to the final document of the "Fourth Meeting of the Conference of

the Parties to the Minamata Convention" (COP-4) in March 2022, in Annex A, that "*amalgam should not be allowed for the treatment of primary teeth, for patients under 15 years of age and for pregnant women and women who breastfeed their babies, except when deemed necessary by the dental surgeon based on the patient's needs*"[7].

In Brazil, in August 2022, the Brazilian Group of Dentistry Teachers (BGDT), motivated by a great controversy around the safe removal of amalgam restorations present on social media, published on its website an "Official note on the safety of the use, removal and disposal of silver amalgam". In this document, it positioned itself against the excessive alarm around mercury contamination and the removal of old amalgam restorations, through an unnecessary, invasive, exaggerated and unsupported drug arsenal in the scientific literature[8]. The same document reinforced the recommendations published by COP-4, previously described, together with the prohibition of the use of mercury in bulk by dental surgeons, being allowed only the use of amalgam in its encapsulated form, remembering that this measure has already been adopted in Brazil since the edition of the Collegiate Board Resolution (CBR) 173/2017 of the National Health Surveillance Agency (ANVISA), which had practical effects in the country from January 2019[9]. These measures were later endorsed by the Ministry of Health, through Technical Opinion No. 6/2022[10].

Given this context, over the last decades, a great reduction in the execution of amalgam restorations has been observed in both private and public clinics, as well as in the clinics of dental education institutions [4,11].

These findings have motivated extensive discussions involving teachers from dental education institutions in Brazil, professionals from the public and private areas, as well as class entities, in order to answer the question: is it still necessary to teach amalgam in dentistry courses?

In October 2014, a Symposium was held at the University of São Paulo, under the theme "Dental amalgam: What is the future of teaching?"[4] and, in January 2015, another discussion took place during the 21st BGDT Meeting, with the theme "Should we continue teaching amalgam?"[11,12] to deepen this theme. The results of these events indicated that, at that time, there was no restorative material capable of totally replacing the amalgam, due to its clinical performance qualities, with greater longevity and significantly lower cost than that of composite resins and concluded that this material should remain as undergraduate teaching content because it has an important indication for the promotion of oral health[12].

It is known that, in Brazil, amalgam continues to be used mainly in the public service and by some dental plans. However, there are no current data on the magnitude of the use of amalgam restorations, especially in the Brazilian public service, since this information has not been included in the SIA/SUS since 2008[4]. Few investigations have emerged on this subject, but in a retrospective study based on practice[13], the authors found that 85% of the subsequent restorations performed in a public health service in a municipality in southeastern Brazil were made with amalgam.

Another important aspect to be considered is that despite the high clinical success rate of composite resin restorations in posterior teeth, reaching a degree of longevity of up to 33 years[14], these procedures still present a higher cost compared to amalgam[15] and also require greater clinical work time due to requiring a more thorough technique, with strict humidity control through absolute isolation. These limitations are even more important when it comes to the public service, considering the high demand, combined with the shorter clinical time to perform the procedure, in addition to the scarcity/lack of material for absolute isolation, which can compromise the final result and, consequently, the longevity of the restoration.

In view of the above, recognizing the unquestionable reduction in the use of amalgam, it is evident that the discussion inherent to the need to teach this restorative material goes beyond the walls of the academy and is taken to the professional dental-surgeon, executor of these procedures and responsible for decision making, in relation to the selection of the material to be used.

Thus, this study sought to identify the perception of dental-surgeons about the need to continue teaching amalgam in dentistry courses.

METHODS

This is a descriptive cross-sectional study whose data were collected using a semi-structured questionnaire (Figure 1), applied to dentists enrolled in the Regional Council of Dentistry (RCD) of the state of Rio Grande do Norte, from May to August 2020. The estimated number of professionals was 3,350 during the data collection period, according to the RCD.

The questionnaire, structured on the Google Forms® platform, addressed aspects related to sociodemographic conditions, the training of professionals to perform these procedures, knowledge about material management and waste

management and, especially, about the perception of professionals regarding the need to continue teaching the amalgam in undergraduate courses.

Age
Gender: ( ) Male ( ) Female
Training Institution:_____
Year of formation: _____
Has specialization: ( ) Yes ( ) No
Work in which service:
If so, which one? _____
( ) Public ( ) Private ( ) Both

1. For posterior tooth restorations what restorative materials are available in your service?
( ) Amalgam.
( ) Amalgam and Composite Resin
( ) Composite Resin
( ) Other _____

2. Having amalgam availability at your service, do you make restorations with this material?
( ) Yes
( ) No

3. In the case of amalgam restorations, what form of manipulation is used in your service?
( ) Mechanical amalgamator
( ) Not applicable
( ) Capsule amalgam
( ) Others

4. Regarding the previous question, how is the disposal of amalgam waste done?
( ) Common trash
( ) Specific container to be later disposed of as medical waste
( ) Not applicable
( ) Other _____

5. During the undergraduate course, did you have theoretical and practical classes on how to work with the amalgam in posterior teeth restoration?
( ) I only took theoretical classes
( ) I practiced in the clinics/between 5 and 10 times
( ) Theoretical classes, but the practices were only in the laboratory
( ) Practiced in clinics/more than 10 times
( ) I didn't see this content
( ) Practiced in clinics/less than 5 times

6. In this sense, do you feel able to carry out the various types of restoration with the amalgam?
( ) Yes
( ) No

7. If you answered 'no' in the previous question, why not?
( ) I didn't practice enough in college.
( ) This topic was not the subject of teaching
( ) Restorative material (amalgam) was not available in clinics
( ) Not applicable
( ) Other _____

8. Currently, with so many materials available, do you think it is necessary to continue using amalgam in the dental clinic? Please, explain your answer.

9. In this perspective, should undergraduate courses in Dentistry continue to have this content in the course of dentistry? Please, explain your answer.

Figure 1. Questionnaire applied to dental surgeons.

After the Institutional Research Ethics Committee/UFRN approved the study under Opinion number 3,996. 271 (CAAE: 31055620.8.0000.5537), the recruitment of participants occurred through electronic correspondence (e-mail), containing the abstract of the research project and the link to access the virtual Informed Consent Form (ICF) and the questionnaire.

The data related to the objective answers were analyzed by descriptive statistics and the subjective data extracted from the two open questions were processed in the IRaMuTeQ software – *Interface de R pour les Analyses Multidimensionnelles de Texte set de Questionnaires* (*Laboratoire d'Études et de Recherches Appliquées en Sciences Sociales of the University of Toulouse*, FR), created to process textual data.

As a computer program, it enables different types of textual data analysis, from the simplest, such as basic lexicography, which covers lemmatization and word frequency calculation, to multivariate analyses such as Descending Hierarchical Classification (DHC), Correspondence Post-factorial Analysis (CFA), Similitude Analysis, Word Cloud and Specificity Analysis. In lexical analyses, statistical methods are applied to textual material, enabling the elaboration of natural categories or classes, based on the use of a statistical technique applied to *corpus*[16], which overcomes the dichotomy

between quantitative and qualitative, making it possible to quantify essentially qualitative variables and show the complementarity between research approaches.

The DHC method classifies text segments according to their respective vocabularies, thus obtaining classes that have similar and different vocabularies[16]. This tool processes large volumes of text in a short period of time, providing the researcher with various pieces of information, which can be interpreted later, using qualitative research techniques such as Content Analysis[17].

This technique of analysis, in turn, obeys a sequence of stages starting with the "floating reading" whose purpose is to glimpse the textual material in its fullness and to get to know the text and the context in a first contact. The *corpus* is prepared according to its own rules and processed by IRaMuTeQ, which groups by semantic similarity the words that appear in the speeches of the interviews and that keep common meanings among themselves, dividing the textual material into classes, which together will compose the dendrogram. In this stage called categorization, we seek to identify the relevant contents of the testimonies in each class, extracting and organizing them to be discussed in the light of the documents and the theoretical framework, or illustrating significant moments of the discussion, generating an AFC graph. This graph represents on a Cartesian plane the different words and variables associated with each of the DHC classes, such as a map, where you can see the approximation or distance of the words and their classes.

Another analysis that IRaMuTeQ offers in data processing is the word cloud, which groups and graphically organizes words according to their frequency. It is a simpler but graphically interesting lexical analysis, as it visually enables the rapid identification of *corpus* keywords and their importance in context, either by font size or proximity to the center of the cloud.

RESULTS

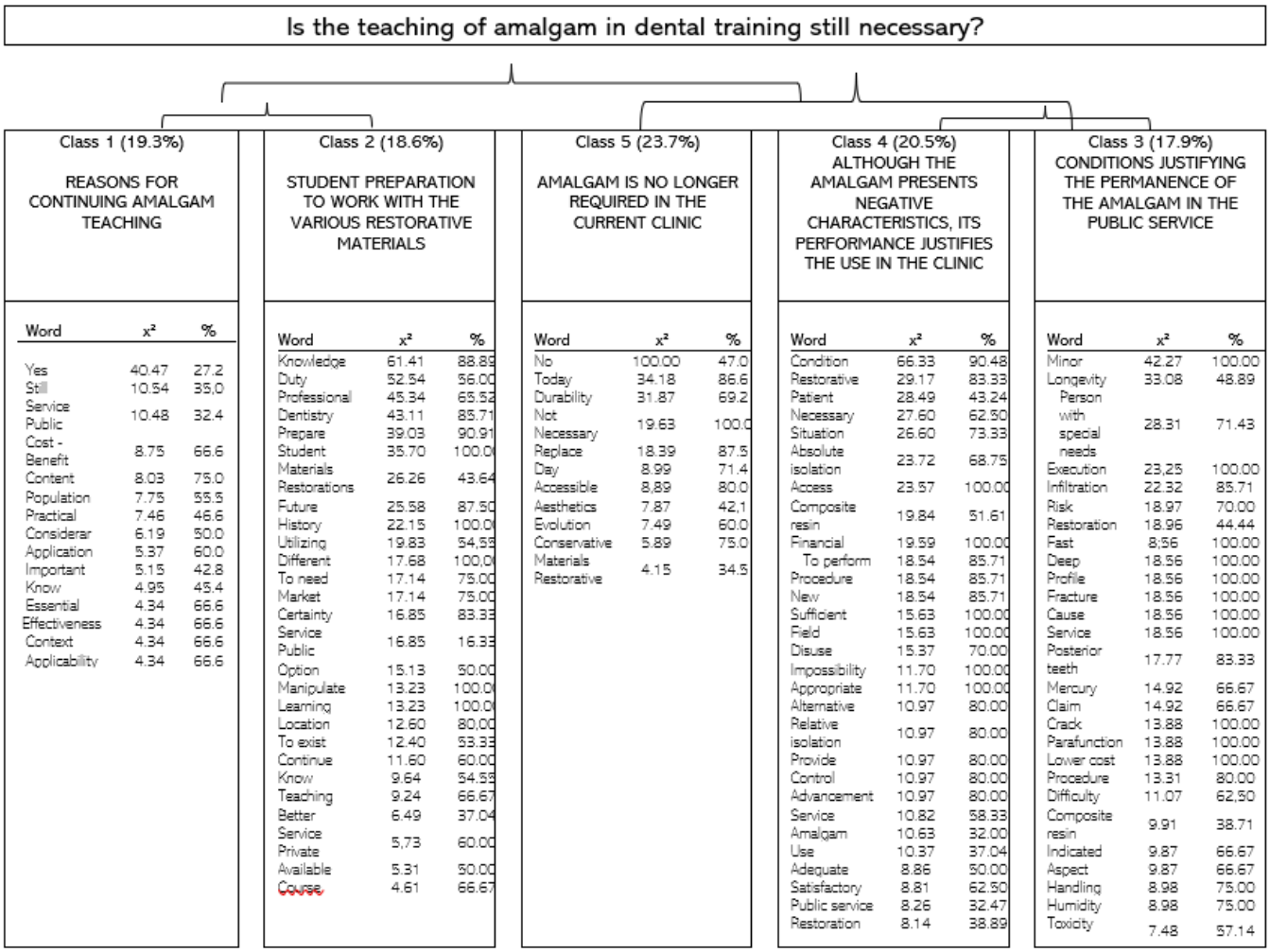
Of the 3,550 dental-surgeons with active email addresses who were recruited, 257 (7.2%) responded to the questionnaire. Regarding the profile of the study participants, a mean age of 37 years was observed, predominantly female (n=166, 64.6%), with training in public institutions (n=171, 66.5%). The average length of training was 13 years, 145 (56.4%) had a specialization course, 72 (28%) were exclusively from the public service, 114 (44.4%) were exclusive from the private service, in addition to 71 (27.6%) individuals who exercised their professional functions in both types of service.

When asked about the restorative materials for posterior teeth available in the services where they work, 167 (65%) indicated the availability of both composite resin and amalgam, 84 (32.7%) only composite resin, 2 (0.8%) only amalgam and 4 (1.5%) answered others. From the perspective of the existence of amalgam in the service in which they work, 156 (60.7%) stated that they would perform restorations with this material, while 101 (39.3%) would not perform even having this availability.

Regarding the training process to perform amalgam restorations, 131 (51%) said they had practiced more than 10 times in the undergraduate clinics, while 39 (15.2%) had only theoretical and laboratory practice classes. Asked if they felt able to perform amalgam restorations, 215 (83.7%) said yes. For those who answered negatively (n=42, 16.3%), the main justification was the fact that they did not practice enough at undergraduate course (n=31, 73.8%).

With reference to aspects of material handling, 184 (71.6%) of the dental-surgeons reported using amalgam in their daily routine. Of these, 169 (91.8%) used the material in capsule, 14 (7.6%) used the mechanical amalgamator and 1 (0.5%) could not say which method. Regarding the disposal of waste, 178 (95.7%) used a specific container to be disposed of in hospital waste, 3 (1.6%) use common waste and 3 (1.6%) did not know how to respond.

When asked about the need for the permanence of amalgam as a restorative material in the dental clinic, even with the existence of more current materials, 163 (63.4%) of the responding dentists stated that they still considered it necessary. Finally, when asked if dentistry courses should continue to provide content on amalgam restorations, 226 (88%) said yes. The answers to these two questions were analyzed from the processing by IRaMuTeQ whose DHC resulted in the emergence of five classes/categories named according to the Dendrogram (Figure 2).



Word	x²	%
Yes	40.47	27.2
Still	10.54	35.0
Service Public	10.48	32.4
Cost - Benefit	8.75	66.6
Content	8.03	75.0
Population	7.75	55.5
Practical	7.46	46.6
Considerar	6.19	50.0
Application	5.37	60.0
Important	5.15	42.8
Know	4.95	45.4
Essential	4.34	66.6
Effectiveness	4.34	66.6
Context	4.34	66.6
Applicability	4.34	66.6

Word	x²	%
Knowledge	61.41	88.89
Duty	52.54	56.00
Professional	45.34	65.52
Dentistry	43.11	85.71
Prepare	39.03	90.91
Student	35.70	100.0
Materials Restorations	26.26	43.64
Future	25.58	87.50
History	22.15	100.0
Utilizing	19.83	54,55
Different	17.68	100,0
To need	17.14	75.00
Market	17.14	75.00
Certainty	16.85	83.33
Service Public	16.85	16.33
Option	15.13	30.00
Manipulate	13.23	100.0
Learning	13.23	100.0
Location	12.60	80,00
To exist	12.40	33.33
Continue	11.60	60.00
Know	9.64	54,55
Teaching	9.24	66.67
Better	6.49	37.04
Service Private	5,73	60.00
Available	5.31	30.00
Course	4.61	66.67

Word	x²	%
No	100.00	47.0
Today	34.18	86.6
Durability	31.87	69.2
Not Necessary	19.63	100.0
Replace	18.39	87.5
Day	8.99	71.4
Accessible	8,89	80.0
Aesthetics	7.87	42,1
Evolution	7.49	60.0
Conservative	5.89	75.0
Materials Restorative	4.15	34.5

Word	x²	%
Condition	66.33	90.48
Restorative	29.17	83.33
Patient	28.49	43.24
Necessary	27.60	62.50
Situation	26.60	73.33
Absolute isolation	23.72	68.75
Access	23.57	100.00
Composite resin	19.84	51.61
Financial	19.59	100.00
To perform	18.54	85.71
Procedure	18.54	85.71
New	18.54	85.71
Sufficient	15.63	100.00
Field	15.63	100.00
Disuse	15.37	70.00
Impossibility	11.70	100.00
Appropriate	11.70	100.00
Alternative	10.97	80.00
Relative isolation	10.97	80.00
Provide	10.97	80.00
Control	10.97	80.00
Advancement	10.97	80.00
Service	10.82	58.33
Amalgam	10.63	32.00
Use	10.37	37.04
Adequate	8.86	50.00
Satisfactory	8.81	62.50
Public service	8.26	32.47
Restoration	8.14	38.89

Word	x²	%
Minor	42.27	100.00
Longevity	33.08	48.89
Person with special needs	28.31	71.43
Execution	23,25	100.00
Infiltration	22.32	85.71
Risk	18.97	70.00
Restoration	18.96	44.44
Fast	8;56	100.00
Deep	18.56	100.00
Profile	18.56	100.00
Fracture	18.56	100.00
Cause	18.56	100.00
Service	18.56	100.00
Posterior teeth	17.77	83.33
Mercury	14.92	66.67
Claim	14.92	66.67
Crack	13.88	100.00
Parafunction	13.88	100.00
Lower cost	13.88	100.00
Procedure	13.31	80.00
Difficulty	11.07	62,50
Composite resin	9.91	38.71
Indicated	9.87	66.67
Aspect	9.87	66.67
Handling	8.98	75.00
Humidity	8.98	75.00
Toxicity	7.48	57.14

Figure 2. Dendrogram of the descending hierarchical classification of the content referring to the corpus, "Is the teaching of amalgam in dental training still necessary?"

Description of the five classes

The analysis of the textual *corpus*, referring to the use of amalgam today, was performed with the aid of IRaMuTeQ from 1,149 words that appeared 9,808 times. Considering the total number of forms that the words presented in the text, 94.54%, were common among respondents, which gives homogeneity to the topic addressed.

The *corpus* was recognized with the separation of 514 initial context units (ICU), which was later divided into 561 elementary context units (ECU), and of these, 414, that is, 80.54% of the text segments of the entire corpus, were equated through DHC, generating five distinct semantic classes. DHC took into account the association of classes to the fixed variables of the study as shown in Figure 3.

Through the DHC, the IRaMuTeQ presented the dendrogram (Figure 2) of the classes obtained from the *corpus* "Is the teaching of amalgam in dental training still necessary?" For its construction, which illustrates the partitions made in the *corpus* and for the subsequent analysis, those words that obtained chi-square (X^2) greater than or equal to 3.84 and $p \leq 0.05$ were considered relevant, according to criteria established by the *software* itself. Each class was represented by the most significant words and their respective associations with the class, that is, the higher the value of the X^2 of the evocation, the greater its association. It can be identified, through the dendrogram, that DHC gave rise to five classes, which were named after the distribution of text segments. At first, the corpus was divided into two axes, giving rise to class 1 and 2 on the left, as opposed to the other classes. In a second moment, the axis to the right was divided again, thus originating class 5, which later, in a third moment, originated classes 4 and 3. According to the most frequent words in each class and their vocabularies, these were named, analyzed and discussed in the light of the proposed theoretical framework. Thus, the criteria for inclusion of the elements in their respective classes are: the frequency greater than the average of occurrences in the *corpus* and the association with the class determined by the chi-square value equal to or greater than 3.84, considering that the calculation for this test is defined according to degree of freedom 1 and

significance 95%[16]. Thus, it can be identified that DHC gave rise to 5 classes, which were named after the distribution of text segments.

INDIVIDUAL	ind_01 to ind_257
GENDER	sex_1: male sex_2: female
LENGTH OF TRAINING	tf_1: 1973-2000 tf_2: 2001-2010 tf_3: 2011- current days
EDUCATIONAL INSTITUTION	If_1: public If_2: private
SPECIALIZATION	esp_1: Surgery, Endodontics, Imaging, Implantodontology, Orthodontics esp_2: Dentistry, Periodontics, Prosthesis, Pediatric Dentistry esp_3: Collective Health esp_4: does not have
SERVICE	serv_1: both serv_2: public serv_3: private
QUESTIONS	quest_8: Currently, with so many materials available, do you think it is necessary to continue the use of amalgam in the dental clinic? Please, explain your answer. quest_9: From this perspective, should undergraduate courses in Dentistry continue to have this content in the course of dentistry? Please, explain your answer.

Figure 3. Coding of the study variables: individual, sex, length of training, training institution, specialization, service and subjective question.

Speeches according to classes

Class 1 - Reasons for continuing teaching amalgam

Class 1 was called "Reasons for the continuity of amalgam teaching", with 19.3% of the ECU, that is, 80 text segments from the entire *corpus*. The main words associated with this class were: yes, also, public_service, cost_benefit, content, population, practice, application, knowledge, applicability among others.

The informative content of this class allowed us to apprehend the view of dental-surgeons regarding the importance of continuing the teaching of amalgam to students, also considering its applicability in public services.

The excerpts from the text segments that illustrate this understanding are exposed below.

> *"Yes, the content should be taught because most of the population still has amalgam_restoration, but practical preparation classes and how to condense, for example, do not seem to have more functionality. The important thing for academics is to know how to behave in the face of an amalgam_ restoration already present in the patient's mouth, if it needs to be removed if a dental_fracture occurs". (**** *ind_158 *sex_2 *tf_2 *if_1 *esp_1 *serv_2 *quest_9).*

> *"Yes, due to the cost-benefit in relation to the purchasing power of the Brazilian population, a restorative_material is shown that still has its use."* (**** *ind_2 *sex_2 *tf_3 *if_1 *esp_4 *serv_3 *quest_9).

From the DHC, it is possible to recover, in the original *corpus*, the text segments associated with each class, at which time the context of statistically significant words is obtained, allowing a more qualitative analysis of the data.

Class 2 - Preparation of the student to work with the various restorative materials

Class 2 was called "Preparing the student to work with the various restorative materials", with 18.6% of the ECU, that is, 77 text segments from the entire *corpus*. The main words associated with this class were: knowledge, duty, professional, dentistry, prepare, student, restorative_materials, future, history, use, among others. According to the frequency of words in the class, the importance and need of the professional, whether in the public or private service, to

have technical and scientific knowledge of the restorative materials still offered in the market. Expressive speeches of this class are shown below.

"Yes, the use of amalgam in the daily life of the dental clinic is still something present and successful with regard to the functional aspects of restorations. Despite the increasingly reduced use, the student and future professional must be qualified for its correct use, in order to be prepared for the different workplaces, especially in the public_service." (**** *ind_68 *sex_1 *tf_1 *if_1 *esp_2 *serv_3 *quest_9).

"Yes, in Brazil we, dental surgeons still face the labor market in which we still offer silver amalgam as a dental_restoration option mainly in the public_service and there are still many studies that prove the effectiveness of this restorative_material. Therefore it is indispensable that future professionals in the field are prepared to come across current and old dental restorative materials". (**** *ind_74 *sex_1 *tf_3 *if_2 *esp_4 *serv_1 *quest_9).

Class 3 - Although amalgam has negative characteristics, its performance justifies its use in the clinic

Class 3 was called "Although the amalgam presents negative characteristics, its performance justifies the use in the clinic", with 17.87% of ECU, that is, 74 text segments from the entire *corpus*. The main words associated with this class were: lower, longevity, patients_with_special_needs, execution, infiltration, risk, fast, deep, profile, fracture, teeth_post, para_function, lower_cost, hygiene, difficulty, among others. In this context, there is a predominance of texts that bring a defense regarding the permanence of the amalgam, in view of its use in public services. The amalgam is an option for use in view of its advantages regarding the technique of manipulation and insertion, as well as its indication for specific groups of the population, according to the following statements.

> *"Yes, I emphasize that it is a restorative_material that best serves patients_with_special_needs, as it does not suffer as much alteration and risk of infiltration due, for example, to difficulties in saliva control during restoration". (**** *ind_63 *sex_1 *tf_3 *if_1 *esp_4 *serv_2 *quest_8).*

"Yes, as an endodontist I see many cases of fractures related to cracks and resulting from extensive amalgam restorations, but I am in favor of amalgam and I believe in its indications mainly in public_service, due to the clinical time, due to the execution, because a badly executed composite_resin causes greater damage in a greater number of cases than a poorly applied amalgam in very extensive restorations and in patients with para_function." (**** *ind_192 *sex_2 *tf_2 *if_1 *esp_1 *serv_3 *quest_9)

Class 4- Conditions that justify the permanence of the amalgam in the public service

Class 4 was called "Conditions that justify the permanence of the amalgam in the public service", with 20.53% of the ECU, that is, 85 text segments from the entire *corpus*. The main words associated with this class were: condition, restorative, patient, necessary, situation, absolute_isolation, access, composite_resin, financial, performing, disuse, among others. In this sense, the present text segments address the awareness of respondents regarding the various negative characteristics of the amalgam, in addition to the presence of other materials that replace it, such as composite resins; however, defend its use in the clinic for the performance it presents. It is worth mentioning the similarity of this class with class 3, previously presented, thus corroborating the use of amalgam in the dental clinic of public services. Next, expressive text segments of this class.

> *"Yes, especially for the public_service, as it is a restorative_material that is indicated for patients who do not do adequate hygiene, the operational time is faster and the longevity is longer". (* ****ind_254 *sex_2 *tf_3 *if_2 *esp_4 *serv_2 *quest_8).*

> *"Yes, in view of the longevity of the restorative_material, resistance and lower risk of restoration failure, in cases where absolute_isolation or even relative_isolation is hampered". (**** *ind_193 *sex_2 *tf_3 *if_1 *esp_2 *serv_2 *quest_8).*

Class 5- Amalgam is no longer needed in the current clinic

Class 5 was called "The amalgam is no longer necessary in the current clinic", with 23.67% of ECU, that is, 98 text segments from the entire *corpus*. The main words associated with this class were: no, today, durability, unnecessary, replace, day, accessible, aesthetic, evolution, conservative and materials_rest. The text segments that make up this class are characteristic of those that advocate the removal of amalgam in replacement of composite resins. The context is exemplified from the segments of speeches.

"No, with the evolution of adhesive_systems as well as composite resins, with the addition of charge particles in their matrix, today we have restorative_material that can replace the amalgam with advantages and with this we can be

more conservative in the preparations, in addition to returning the proper function and shape, we also return the aesthetics by doing an inconspicuous restorative work and through that contributing to raising the patient's self-esteem." (**** *ind_127 *sex_2 *tf_1 *if_1 *esp_2 *serv_3 *quest_8)

"No, I think today in my clinic there are restorative_materials that replace amalgam". (**** *ind_108 *sex_1 *tf_1 *if_2 *esp_2 *serv_3 *quest_8)

The IRaMuTeQ *software*, when processing the AFC graph (Figure 4), from the DHC, generates the representation of the positioning of the classes of words in the textual *corpus*, being able to see which classes complement and focus on the *corpus*, and which ones distance themselves from the center and show a certain specificity, as is the case of class 5, which with its very specific vocabulary is contrary to the other classes with regard to the continuity of the use of the amalgam.

In the textual analyses of the IRaMuTeQ, it is still possible to verify the occurrence rates of the words, which were evoked in the responses of the dental surgeons responding to the subjective questions. This method, called Word Cloud (figure 4), is a simpler lexical analysis, but graphically didactic and visually expressive, where we can visualize, through the graph, the vocabulary most used in the *corpus*.

In the graphical interpretation of the Cloud of Words (Figure 5), they have their size directly proportional to the frequency of evocation in the transcribed *corpus*, from the answers to the two subjective questions. Thus, the larger the word, its more central location in the cloud and bold of stronger traits, the more significant the word in the general context of the *corpus*. Those that had the highest frequency: yes (294), no (185), amalgam (112), public_service (77), composite_resin (75), still (57), restorative_material (55), use (54), duty (50), longevity (45), restoration (36), durability (26), option (22) and indication (16), grouping the five classes emerging from the DHC, which reflect the perception of the respondents about the continuity of the amalgam.

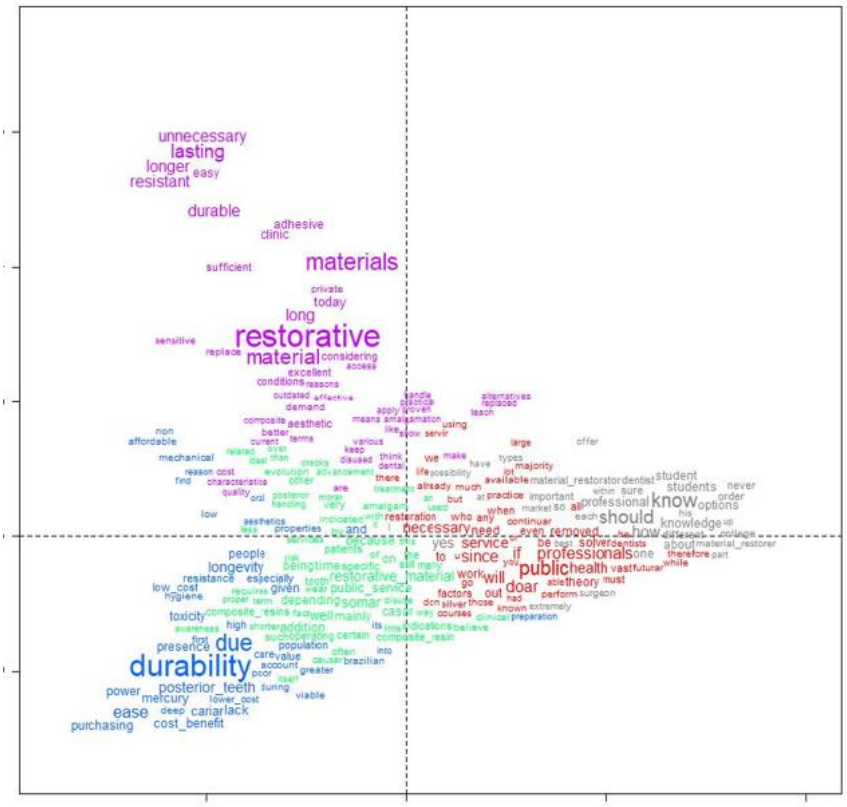


Figure 4. Correspondence Factor Analysis, generated by IRaMuTeQ from the Descending Hierarchical Classification. Red-Class 1, Grey-Class 2, Green-Class 3, Blue-Class 4 and Lilac-Class 5.

Figure 5. Word cloud grouping the five classes emerged in the DHC processed by IRaMuTeQ.

DISCUSSION

Much has been questioned about the need for dentistry courses to dedicate a large part of their workload to the teaching of amalgam restorations, even though there is a finding that the number of procedures performed with this material has declined significantly in recent times, including in the clinics of dental education institutions. It is understood that this reduction results from discussions about the risks of mercury contamination, as well as the evolution of adhesive materials and techniques with scientific evidence that verify the effectiveness of composite resins.

Regarding the toxicological aspects of mercury, many controversies have arisen since the disclosure of the decisions of the Minamata Convention in 2013[5], generating much confusion in the interpretation of the results of this convention. False news has been trumpeted that amalgam restorations have been banned by this international treaty. Fortunately, almost 10 years later, in August 2022, after the circulation of sensationalist publications on social networks, the BGDT published an official note with fundamental clarifications for the dental community stating that the treaty of the Minamata Convention, to which Brazil is a signatory, never placed amalgam restorations as a risk to people's health. It also reaffirms that important bodies such as the *American Dental Association* (ADA), the *Food and Drug Administration* (FDA) and the *World Dental Federation* (FDI) confirm that amalgam is a safe and durable restorative material [8].

It is necessary to clarify that the treaty recommended the gradual reduction of amalgam, the encouragement of the development of quality and mercury-free materials for dental restorations and the care with the disposal of all mercury-containing products, without prohibitive measures or deadline for banning, since the greatest source of human contamination does not occur by the mercury contained in an amalgam restoration, but by other sources, especially by the ingestion of contaminated water fish[8].

It is imperative to emphasize that prohibitive decisions on the use of amalgam in specific situations only emerged from COP-4[7] in March 2022, which restricted the use of amalgam in children under 15 years, pregnant women and women lactating their babies, leaving the decision to use it to the dentist, according to the individuality of the patient. Therefore, the choice of dental material will depend on shared decision making between dental professionals and patients in the clinical setting, as well as local guidelines and protocols [15].

Based on this understanding, the autonomy of professionals in their clinical decisions is legitimized, corroborating the results of the present study, when participants reported the almost compulsory use of amalgam, for example, in special needs patients (SNP), given the difficulty of managing these individuals and the complex applicability of other restorative materials, as illustrated by the following statements.

> *"Yes, because I work with patients_with_special_needs and some do not collaborate in the care, do not have patience, being faster the working time and allowing greater resistance. We cannot follow the stages that a composite_resin requires". (**** *ind_66 *sex_2 *tf_1 *if_1 *esp_4 *serv_3 *quest_8).*

> *"Yes, because due to the working time it is a good option for restorations in patients_with_special needs, where it does not have a satisfactory collaboration in the execution of the restoration". (**** *ind_26 *sex_2 *tf_3 *if_2 *esp_4 *serv_3 *quest_9).*

Another aspect to be considered concerns the discussions about the progressive elimination of amalgam in some countries that consider it difficult or even impossible to meet the proposed schedule, due to the economic and technical aspects [18]. It is understood that in this scenario, Brazil can be classified, due to the debasing social inequalities, the lack of effective and continuous public policies, in addition to the difficult and restricted access to health services. The respondents' statements show that these conditions are still notorious, alive and present in the Brazilian reality, which reaffirms the need to teach this content and use the amalgam, especially in the public service, where this demand is more present, as evidenced by 88% of the sample of this study.

> *"Despite the worldwide trend of disuse of this material, the reality of our country, especially in the public service, and areas with little structure and population of few resources, the use of a longevity material is still essential. Maintaining the subject is to provide graduates with the ability to deal with the reality of the Dentistry panorama in all social stratifications of the country" (**** *ind_32 *sex_1 *tf_3 *if_1 *esp_4 *serv_3 *quest_9).*

*"Yes, the courses should continue with the teaching of this content, because as many patients still have amalgam restorations, it is necessary for students to know this restorative material, its technique, indications and contraindications. This will be important to know if the replacement of these restorations is indicated. In addition, knowledge of this restorative_material is indispensable so that all care regarding the correct disposal of waste is taken". (**** *ind_239 *sex_2 *tf_3 *if_1 *esp_4 *serv_3 *quest_9)..*

Still on the contribution of amalgam in environmental contamination, it is worth highlighting the aspects related to the management and disposal of waste. In the present study, it was evident that dental surgeons were directed to comply with ANVISA Resolution-RDC 173/2017 [9], as 91.8% of respondents reported using encapsulated amalgam and 95.7% reported disposing of it in an appropriate container and in hospital waste, subsequently collected and treated by specialized companies.

In addition to the environmental issue caused by mercury, another important aspect in the discussion about the elimination of dental amalgam has been the risk of dental fracture that this material can provide. It is observed that teeth restored with amalgam, especially those that involve the proximal surfaces with removal of the marginal ridges, end up weakening the dental remnant by the absence of adhesion to join the walls[19]. This aspect reinforces the importance of continuing education in the work process, which is fundamental for decision making regarding the restorative material to be used. It is known that the use of adhesive materials, such as composite resins, promotes the return of greater strength to the dental structure.

The best biomechanical behavior of adhesive materials in maintaining the strength of the dental remnant is unquestionable. However, it is important to consider that the failures of restorations in posterior teeth are not only related to the properties of the material, but also depend on the habits of the patient and the performance of the operator[20].

A study evaluated the factors associated with the survival of posterior tooth restorations performed in public health service units in a Brazilian municipality, and concluded that both materials, amalgam and composite resin, presented a high survival rate, being the most important factors for the longevity of restorations, the time of training of dentists, the quality of users' access to the health service and the number of restored faces of the dental element [13], confirming the results of Afrashtehfar *et al.* (2016)[21], who observed the influence of the amount of dental remnant as a determinant in the failures of posterior tooth restorations. Regarding the training of the dental surgeon, it is important to highlight a recent study, which reports clinical success of composite resin restorations, monitored for up to 33 years and performed by the same operator, highlighting the importance of professional qualification [14].

Thus, it is up to reflection whether it is possible to abruptly remove the amalgam from the arsenal of restorative materials, considering that composite resin restorations require a highly sensitive and thorough technique, with regard to the quality of adhesive materials, photo activating devices, the need for absolute insulation, as well as an adequate time for carrying out these procedures. It is known that this is not the reality in most offices in the public service and some dental plans in Brazil, which have a great demand of users, as well as high demands on the part of management regarding the number of patients to be attended. Here are the statements that express this reality.

> *"Yes, it is still an interesting option in these cases that I mentioned, especially in the public service where it took us months to reassess. Glass_ionomer _cement and composite resins do not last in several patients_with_special_needs and with para_function. If I hadn't learned how to use amalgam, in a way it would*

> *be damaging the flow of the service I work today, which requires a turnover due to the great demand, in addition to the manipulation being faster. Patients_with_special_needs do not always go to the operating room or sedation, so I need something that I can put faster, without so many stages". (**** *ind_104 *sex_2 *tf_3 *if_2 *esp_4 *serv_2 *quest_9).*
>
> *"Yes, permanence is fundamental and I believe it should be more encouraged among young dentists. The reality in most of the basic_health_units of the various family_ health_ strategies of the state is low quality composite resins with rare diversity for stratification, photopolymerizers that have never undergone maintenance and of course, the absolute_isolation of the workers' field is something never seen, even relative_isolation is difficult. I already had only ten cotton rollers to serve nine patients and perform restorative procedures on all of them. So, in many situations, amalgam comes in as a valid resource for a dental_surgeon who wants to deliver a long-lived, quality job". (**** *ind_4 *sex_1 *tf_3 *if_1 *esp_3 *serv_2 *quest_8).*

Regarding the public service, there is still a need for restructuring, not only in the replacement of the amalgam by the composite resin, but in the reorganization of demand, the improvement and increase of access, the implementation of the physical structure and the hiring of more professionals so that the population is not penalized in meeting their health needs. In this perspective, Pereira *et al.* (2020)[13] consider that, to improve the longevity of subsequent restorations, a better qualification of professionals, including permanent education programs, and increased coverage of the public dental service, mediated by the promotion of equity in access to health services, would be beneficial.

In this sense, IADR's position in 2019 is indisputable, when it committed to strive to stimulate research on primary prevention and behavior change strategies that would result in a reduction in the prevalence of caries[6]. It is known that this would be essential as long as, at the same time, there were public policies of the state and not of the government, which were continuous, permanent and which actually brought about the change of behavior of the population and the exercise of citizenship.

CONCLUSION

According to the dentists interviewed, considering the social inequalities, the high demand of users, the inadequate conditions of services, the discontinuity of public policies and, despite the great evolution of adhesive materials, amalgam still continues to be used for restoration of posterior teeth, especially in the public service, in which the demand for restorations with low cost and great longevity is high. Thus, professionals believe that amalgam is still necessary in the dental clinic as long as there is no mercury-free material, which is low cost, easy to handle and durable. Therefore, the teaching of this content must remain in the undergraduate courses of Dentistry.

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