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Repair of Dental Restorations: A 10-year Retrospective Analysis of Clinical Data

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Clinical Relevance

The repair of dental restorations is one of the pillars of minimally invasive dentistry. It is clinically relevant to show that the number of repairs has increased over the years in a dental school as this may have an impact on the clinical decisions of professionals of future generations.

SUMMARY

Objectives: This study collected and analyzed clinical data regarding the repair of dental restorations in patients treated in the clinics of a dental school over 10 years.

Methods and Materials: Data related to repair procedures for permanent tooth restorations were extracted from the digital dental records system and filtered according to year (January 1, 2008, to December 31, 2017), age (<30, 30-60, >60), tooth group, and dental surfaces. Data were analyzed with descriptive statistics in terms of the absolute and relative frequency, and chi-square tests (95% confidence) were used to compare the frequency of repairs between years, age, tooth, and dental surfaces.

Results: A total of 48,915 dental records were accessed by searching for general restorative procedures, of which 1,408 were repairs of dental restorations on permanent teeth. The number of repairs per year increased over the period assessed, and there was a significant increase in the years 2016 and 2017. Individuals aged between 30 and 60 years received the largest number of repairs, with

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significantly more repairs than the other groups. Regarding the tooth group and surface, the canines and the incisal and lingual surfaces received the least number of repairs.

Conclusions: The number of repairs increased over the study period. When comparing frequencies between groups, those belonging to the 30- to 60-years of age group received more repairs; the least repaired surfaces were the lingual and the incisal.

INTRODUCTION

The decision whether to maintain, repair, or replace dental restorations is a topic of interest.[1,2] In this context, the idea behind minimally invasive dentistry is that by removing only the failing portion of a restoration, it is possible to achieve good clinically restorative performance through a restorative repair.[3-5] When repairing a restoration, compared to doing a complete replacement, advantages include reduced material costs[6] and a shorter clinical time required to perform the procedure, which may reduce the patient's anxiety.[2] In addition, the decision to repair a restoration is a more conservative option compared to the replacement option.[7] The intervention strategy used in minimally invasive dentistry involves the detection of early caries lesions, caries risk assessment, clinical decision-making, and personalized care planning.[8]

Previous studies have suggested that the clinical application of minimally invasive dentistry may be beneficial. Van de Sande and others[9] collected 15 years of data from patient files of a private dental practice, investigating whether restorative repair in anterior teeth was a good clinical alternative to replacement. The authors concluded that a composite resin repair might be a good option for anterior teeth, as it could increase the survival of their restorations over time. In another study[10] that investigated whether restorative repair was a good option for posterior teeth collected 10 years of follow-up data from a private dental clinic, they observed that the repair of posterior restorations reduced the annual failure rate from 4.1% to 2.9%. Similar results were found by Kanzow and Wiegand,[11] who concluded from their retrospective clinical study of 3239 patients that a repair can last as long as a complete replacement, so it can be considered a reliable alternative.

Despite the widespread use of minimally invasive dentistry, Mirsiaghi and others[12] showed that in their sample of clinicians, only 40% of 170 study participants used their knowledge of minimally invasive dentistry properly in their clinical routine. Previous studies[13,14] of dental practitioners found that many dentists (from the Dental Practice-Based Research Network [DPBRN])[15] often replace restorations that are not in optimal condition, regardless of their location, type of failure, number of surfaces, the material, used or time in the oral cavity. On the other hand, more recent studies have shown that some dental practitioners in the DPBRN have changed their clinical course over the years, with data suggesting an increase in repair options compared to replacement.[16,17]

Kanzow and others[18] performed a literature review based on 401 articles and noted that most schools of dentistry teach that repair should be performed to correct partial defects in restorations rather than replacing them completely. The same authors also observed that even though dental schools recommend the dental restoration repair procedure, approximately two-thirds of dental surgeons do not perform such procedures; however, they also reported that the proportion of dentists who perform repairs has increased over the years. Another study by Blum, Lynch, and Wilson[19] investigated data from 12 dental schools in Scandinavian countries (Norway, Denmark, Sweden, and Finland) using a questionnaire method. These authors showed that 11 out of 12 schools included the repair procedure in their primary curriculum. The only school that did not include repair in its curriculum intended to include it in the next five years. In a similar study, Brunton and others[20] assessed the teaching of the repair procedure in the academic environment at schools in Oceania (New Zealand, Australia, Fiji, and Papua New Guinea). All the universities investigated performed repairs and considered the treatment to have been successful, and 13 of 16 considered repair to be an appropriate alternative to complete replacement in their undergraduate courses.[20] Since all these studies demonstrate the importance of assessing the teaching of repair in the academic setting, quantifying its application in university clinics is necessary.

This study collected and analyzed data regarding the repair of dental restorations in patients treated in the clinics of a dental school over 10 years (2008 to 2017). The research hypothesis was that there would be no difference in the frequency of repairs of dental restorations according to the patient's age, tooth group and surface, and year. The clinical relevance of this study relates to the categorization and quantification of dental restoration repairs over time.

METHODS AND MATERIALS

This study was approved by the local research ethics committee (protocol 29695520.5.0000.5419). The data came from electronic dental records of patients

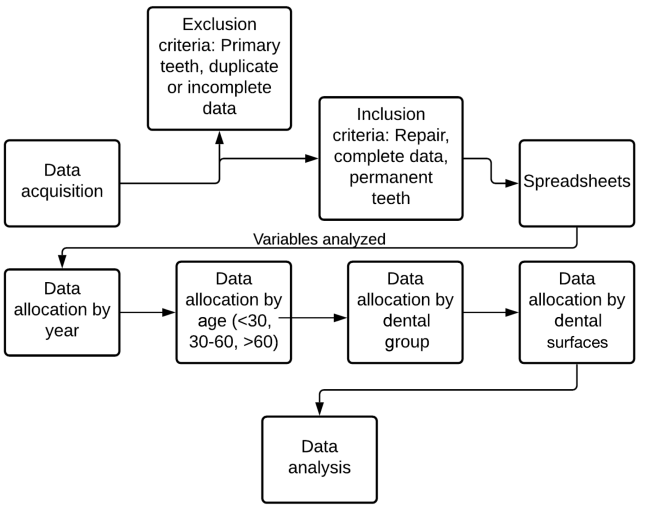

Figure 1. *Flowchart of the methods and processes performed in this study. The items above are related to each step in the Methods section of this article.*

that gave consent to use it. Figure 1 shows the study design.

Electronic dental records from 2008 to 2017 (10 years) were searched in the Romeu database (dental clinic software used at the School of Dentistry, Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo, which was built entirely based on free software solutions, such as PHP computer language and a PostgreSQL database management system (Romeu Database, FORP USP, Ribeirão Preto, São Paulo, Brazil). This database runs on any web browser and has been under development by the Informatic & Technology Team of the Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo (Ribeirão Preto, São Paulo, Brazil) since 2003. A specific search was conducted for procedures containing the word "restoration" in their description, "year," "age," "surface," "teeth," and "patient ID"; this search provided the initial sample. This sample was exported to a spreadsheet. Each line of the spreadsheet recorded the patient's identification number and age (at the time of treatment), the name of the procedure (eg, repair of restoration, resin restoration, amalgam restoration, ionomer restoration); the year in which the procedure was performed; and the tooth number and surface(s), along with the restoration report.

This study included electronic dental records with complete data, without duplication or filling errors, and that referred to the repair procedure for dental restorations performed on permanent teeth, always in composite resin. Electronic dental records with incomplete and duplicate data were excluded from this study, as well as dental records referring to procedures performed on primary teeth.

The following variables were analyzed: a) Repair by year: the number (absolute frequency) of repairs of dental restorations was recorded for each year, from 2008 to 2017; b) Repair by age group: allocated to the following groups-age up to 30 years old (<30), 30 to 60 years (30-60) and greater than 60 years (>60); c) Repair by tooth group: maxillary incisors, mandibular incisors, maxillary canines, mandibular canines, maxillary premolars, mandibular premolars, superior molars, and lower molars; d) Repair by tooth surface: allocated according to buccal, lingual, cervical, occlusal, incisal, mesial, and distal surfaces.

Data were analyzed with descriptive statistics, including the absolute and relative frequency of repairs by year (2008 to 2017), patients age group (<30, 30-60, >60), tooth group (incisors, canines, premolars, molars) and repaired dental surfaces (mesial, distal, buccal, lingual, occlusal, cervical). The chi-square test (95% confidence) compared the frequency of repairs between years, age group, and tooth groups and surfaces.

RESULTS

From the specific search for procedures containing the word "restoration" in their description, a total of 48,915 dental records and 53,436 procedures were found in the Romeu system from 2008 to 2017. Of these procedures, 34,115 surfaces were restored with composite resin, 8,845 with glass ionomer and 1,949 with amalgam. There were 7,566 teeth restored with temporary restorations and 34,277 with permanent restorations; 7,366 in primary teeth and 26,911 in permanent teeth. After excluding dental records that did not fit the inclusion criteria for the study, the repairs of dental restorations involved 1,408 surfaces and 828 teeth. The absolute and relative frequency of repairs of dental restorations per year, considering the age group, are shown in Figure 2, which also shows the percentage of repairs of dental restorations out of the total number of dental restorations performed, suggesting that replacement is gradually being replaced by repair.

Regarding the number of repairs according to dental groups, there were 446 incisor restoration repairs, 124 on canines, 310 premolars and 528 molars (Table 1). There were significant differences between canines versus incisors ($p<0.05$) and between canines vs. molars ($p<0.001$). No significant differences were found between incisors versus premolars, incisors versus molars, canines versus premolars and premolars versus molars. Table 1 also shows the frequency of repair by surfaces according to the dental groups. The frequency of repair

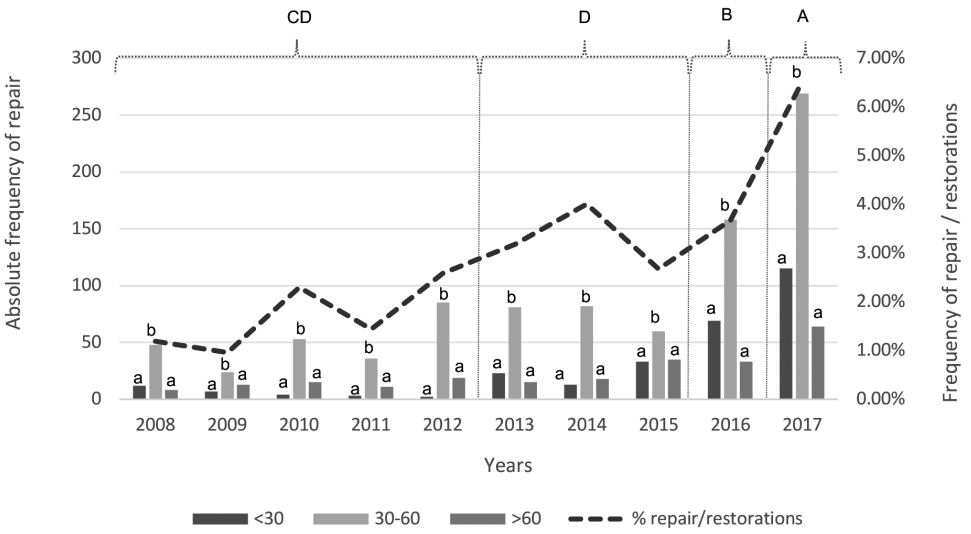

Figure 2. *The columns represent the absolute frequency of repairs of dental restorations per year according to the age group. The dashed line represents the frequency of repairs (% rate) in relation to the total number of restorative procedures. Different lowercase letters, at the columns, represent statistical differences between the age group (chi-square test,* p*<0.05). Different uppercase letters, at the middle part of the brackets, represent differences between the years (chi-square test,* p*<0.05).*

of incisal and lingual surfaces was similar ($p>0.05$), but both differed from the other surfaces ($p<0.001$).

DISCUSSION

This study showed that the frequency of repair of dental restorations increased significantly over the 10 years analyzed; furthermore, the frequency of repair differed significantly between age group, tooth group and surface. Consequently, there was no support for the research hypothesis that there were no differences among years or groups.

Considering the total number of repairs of dental restorations performed from 2008 to 2017, about 90% of the total teeth treated were repaired in 2015-2017. Interestingly, a significant increase in repairs was observed in 2015 and this continued in 2016 and 2017. It is worth mentioning that the rate of restorations/repairs of dental restorations also increased in these years, reflecting a shift in the balance between repair and replace, as shown in Figure 2. Considering the causes for such improvement in repair on dental restorations, we can cite the consistent scientific literature available in the period. For example, Fernandez and others[21] encourage performing repairs, both in resin and amalgam restorations, aiming to increase the longevity of the original restorations. Another study carried out by Martin and others[22] demonstrated that marginal sealing of restorations was a minimally invasive treatment that may be used instead of the replacement of restorations. Gordan and others[16] showed that when a defective restoration was repaired instead of replaced, a new intervention within the first year was less likely. Additionally, Javidi and others[2] observed a reduction in anxiety in patients who underwent repair treatment, which was also associated with a reduction in the

Table 1: *Absolute Frequency of Repair of Dental Restorations by Face and Tooth Group*[a]

	Incisors (a)	Canines (b)	Premolars (ab)	Molars (a)	∑ Faces
Buccal (A)	119	28	50	65	262
Lingual (B)	2	2	3	8	15
Palatal (A)	91	19	17	42	169
Mesial (A)	70	29	56	79	234
Distal (A)	45	18	58	66	187
Occlusal (A)	0	0	76	203	279
Incisal (B)	20	3	0	0	23
Cervical (A)	99	25	50	65	239
∑ Tooth	389	57	87	37	1408

[a]*Different lowercase letters represent significant differences between tooth groups (chi-square test,* p*<0.05). Different uppercase letters represent statistical similarity between the dental faces (chi-square test,* p*<0.001).*

amount of local anesthesia and less cavity preparation. Importantly, Moncada and others[23] concluded that a repair increases the useful life of the original restoration, even after a period of 10 years. Another reason that can justify the increased number of repairs is the decreased number of amalgam restorations that we observed in the electronic records. It is important to mention the Minamata Convention on Mercury's[24] scientific efforts not encouraging the use of dental materials such as amalgam, and with that, when amalgam restorations fail, for several reasons, dentists tend to use a medium or minimally invasive approach to rehabilitate the tooth.[25]

The data found in our study demonstrating the increase in the repair of dental restorations in the academic environment can be corroborated by Blum and others.[19] Although their study differed from ours as it was applied through questionnaires, they concluded that 91.67% of 12 Scandinavian dental schools have repair in their curriculum; Brunton and others [20] observed the same trend in 81% of the 16 schools in Oceania. Despite the acceptance and adoption of repair by dental schools, literature from the United States of America indicates that repairing dental restorations is not the first clinical choice in private dental clinics.[1] In Europe, a study of 1805 dentists by Kanzow and others [3] found that only 2.2% had never performed a repair, whereas the others had repaired restorations of different materials, with resin being the most frequent (93.4%), and others being ceramics, crowns, metallic restorations, and amalgams.

Concerning the repair of dental restorations according to age group, the highest incidence was observed in individuals aged 30 to 60 years. The same occurred for the total number of restorative procedures, with these individuals also receiving the highest number of restorations. Indeed, national epidemiological studies (Brazil) have shown that 35- to 44-year-old individuals have the highest number of teeth restored (7.33%), followed by 15-to-19-year-olds (2.16%) and 65-to-74-year-olds (1.62%);[26] this indicates that the teeth that are restored are lost as the individuals age, and the greater demand for adult dental services. This pattern (highest incidence in 30-60-year-olds) was also observed in other studies, such as that of Javidi and others,[2] in which adult patients represented the largest group in their sample, and both young and elderly individuals accounted for similar significantly smaller proportions of the sample, also consistent with the findings of this study. Van de Sande and others[9] also found that the average age of participants in their study was in the adult age group.

Regarding tooth group, the canines received the lowest frequency of repairs of their dental restorations during the study period, as also reported by Van de Sande and others[9] According to these authors, the incisal surface is considered at high risk of failure because it is subject to great masticatory stress, which indicates why the incisal surface was also one of the least repaired in our study. However, the lingual surface received a similar number of repairs. According to Wilson and others,[4] one of the criteria for performing a repair is esthetics. Thus, the lower number of lingual surface repairs may be related to a lower perception of esthetic failure by patients, which may have reduced the demand for the restorative service.

It is important to mention the role of electronic dental records (EDRs) in identifying trends in clinical decision-making; according to Schleyer and others,[27] 73.8% of DPBRN practitioners use a computer to record their clinical data. EDRs can be used to answer clinical questions, which could lead to improvements in patient care, thus creating a continuous cycle.[28] The process of storing data in EDRs can support analyses such as the one conducted in the current study. As EDR features and the training for filling the system are crucial to collect consistent data, it is worth mentioning how the EDR Romeu works. In the institution where the study was done, the professionals or students that see patients receive a login and password to access the system-that works only under the institutional internet protocol (IP)-and a broad training on how to feed the system (eg, patients' personal data, medical history, treatment plan, upload of images, procedures done). Considering the dental procedures, each has a code number. It is mandatory that together with the code, the tooth number and tooth surface be added. If by any chance the procedures are incorrectly registered, the responsible person sends a written message to the student (through the system) requesting him/her to correct them; in this case, the student is blocked to fill the system with other possible procedures until they correct the incorrect register. Consequently, for the procedure to be recorded in the system as a datum, the professor or person responsible for the clinic must log in and validate each procedure for each patient on a daily basis. In this sense, the major strength of this work was the analysis of data collected consistently over 10 years by a dental school, which indicated a probable scientific, evidence-based change in the way restorative procedures were being taught and practiced. Another contribution of this work is to have shown that the adoption of minimally invasive dentistry-constituted by repair of dental restorations-indeed increased in the institution. However, the rate of repairs per the total number of dental restorations was about 6% (Figure 2); in this context, a multicenter

analysis of similar data could assist the understanding of such a rate.

Nevertheless, EDRs have limitations compared to data collected in clinical trials.[27] For example, in this study the use of EDR data collected no information on the reason for repair (eg, correction of limited marginal openings and cavo marginal ditching, management of localized marginal staining, treatment of early lesions of secondary caries, repair of fractures that do not threaten the viability of the remaining restoration and tooth tissues, chipping of restoration margins, management of wear, correction of unacceptable esthetics, restoration of an endodontic access cavity prepared through an existing restoration).[4] Besides, this study was carried out in an academic setting, thus it is impossible to know whether the same behavior would occur outside the academic environment. Therefore, further studies should involve the assessment of restorative procedures in private dental clinics in the region in which this study was conducted.

CONCLUSIONS

The number of repairs of dental restorations increased over a 10-year period in the dental clinic of the School of Dentistry, Faculdade de Odontologia de Ribeirão Preto, Universidade de São Paulo from which the clinical data was collected, indicating an increase in the trend for minimally invasive dentistry in the academic field. Although it is a widely applicable procedure and has been used in all age groups, tooth groups and surfaces, when comparing frequencies between groups, those belonging to 30- to 60-years-of-age group received more repairs; the least repaired surfaces were the lingual and the incisal.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the ethics committee of the Institutional Review Board of the University of São Paulo. The approval code issued for this study is CAAE: 29695520.5.0000.5419.

Conflict of Interest

The authors of this article certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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