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Repair restorations: Questionnaire survey among dentists in the Canton of Zurich, Switzerland

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SUMMARY

The aim of this study was to carry out a representative survey on the implementation of and experience with repairs of single-tooth restorations among dentists in the Canton of Zurich, Switzerland. An anonymous questionnaire was sent to all 1,411 dentists registered in the Canton of Zurich; 38.9% of the delivered questionnaires were returned and 35.3% could be evaluated. The statistical analysis comprised Kendall's rank correlation coefficient (τ), Wilcoxon signed-rank tests, and Kruskal-Wallis tests. Repair restorations are frequently made (composite: 98.5%, ceramic: 88.9%, crowns: 86.5%, metal: 54.6%, amalgam: 51.5%). Main indications for repairs were the partial loss of an existing restoration or of the adjacent dental hard substance, while restoration failures due to secondary caries were repaired to a lesser extent. The decision to repair is largely dependent on the size of the defect (90%), the size of the original restoration (63%), and the material of the failed restoration (84%). Repair restorations are most frequently made with composite following adequate conditioning of the repair surface. A majority of the dentists rate the lifespan of repair restorations as reduced in comparison with newly made restorations. In summary, repairs of defective single-tooth restorations are frequently performed by dentists in the Canton of Zurich, Switzerland, and constitute a well-established treatment procedure.

Introduction

All dental restorations have an only limited lifespan. Consequently defects in existing restorations frequently have to be treated in dental practice (AL NEGRISH 2001, MJÖR ET AL. 2002, TYAS 2005, BRAGA ET AL. 2007, CHRYSANTHAKOPOULOS 2012, STAXRUD ET AL. 2016). This can be accomplished via either a replacement of the entire restoration or repair measures. The repair of an existing restoration cannot only lengthen its own durability (FERNÁNDEZ ET AL. 2015), but simultaneously also prolong the life of the affected tooth (KANZOW ET AL. 2016b), since in comparison with a newly made restoration, a repair entails reduced loss of dental hard substance. Under certain conditions repair restorations are also considerably more cost-effective than replacement restorations (KANZOW ET AL. 2016b). A substance-sparing and defect-related treatment in the form of a repair restoration therefore conforms to a minimally invasive therapy concept (FRANKENBERGER ET AL. 2014).

During the past years and decades minimally invasive therapy concepts have become established in various areas of restorative dentistry (VIDNES-KOPPERUD ET AL. 2011, FRANKENBERGER ET AL. 2014, DOMÉJEAN ET AL. 2015, OLIVEIRA ET AL. 2016). By comparison within Europe, however, partly great differences are apparent regarding the implementation of such concepts in daily practice (SCHWENDICKE ET AL. 2016).

These differences can possibly be accounted for by the fact that therapeutic decisions do not only depend on various tooth- and patient-related factors (GORDAN ET AL. 2014), but also on the education and experience of the treating dentists (ALANI ET AL. 2011). Similarly the basic conditions for dental care, i.e. the country-specific health care system, could have an influence on the therapeutic decisions.

Thus far only very little information is available regarding the implementation of and experience with repair restorations (KANZOW ET AL. 2016a, STAXRUD ET AL. 2016). Therefore, it was the aim of this study to carry out a representative survey on the implementation of and experience with repairs of single-tooth restorations among dentists in Switzerland (Canton of Zurich). The obtained findings should be compared with already existing data from Norway (STAXRUD ET AL. 2016) and Germany (KANZOW ET AL. 2016a).

Materials and Methods

Questionnaire design

For the present study a standardized questionnaire comprising eleven groups of items was used. A slightly modified version of this questionnaire had already been applied for a survey in Germany. There, it had been subject to an internal validation process, which revealed a substantial test-retest-reliability (KANZOW et al. 2016a). The questionnaire was subdivided into the following groups of items: 1. demographic data, 2. frequency of repairs depending on the material of the original restoration, 3. reasons for repairs, 4. decision criteria for the evaluation of maintainability, 5. indications for the implementation of repairs, 6. materials used, 7. techniques and clinical procedure, 8. patient acceptance, 9. rating on the lifespan of repair restorations, 10. reasons for repairs carried out rarely or never, as well as 11. interest in continuing education on repair methods.

In February 2016, questionnaires together with reply-paid envelopes were mailed by the Department of Health, Zurich, to all dentists registered in the Canton of Zurich (n=1,411). Since replies were anonymous, it was not possible to again contact dentists who had not returned the questionnaire. Seventy-two shipments could not be delivered. After eight weeks the survey was terminated.

Statistical analyses

Data of the questionnaires were first transferred to a database (Excel for Mac 2011, Microsoft, Redmond, Washington, USA). The statistical analyses were subsequently made using the software R (version 3.3.1, www.r-project.org).

The repair frequency as a function of the material of the original restoration was compared using Wilcoxon signed-rank tests and subsequent adjustments of p-values according to Bonferroni-Holm. Kruskal-Wallis tests served for evaluating the effect of various factors (gender, occupational focus, practice location, type of practice) on the frequency at which repairs were implemented. The correlation of the repair frequency with the age of the questioned dentists was determined using the rank-correlation coefficient Kendall's tau. For all tests the level of significance was set at $p \leq 0.05$.

Results

The return rate of the delivered questionnaires (n=1,339) amounted to 38.9% (n=521). Out of these, n=498 questionnaires (204 from females, 294 from males) could be evaluated (35.3% of the delivered questionnaires). Twenty-two participants indicated that they did not pursue any restorative dentistry (orthodontists, oral surgeons, maxillo-facial surgeons).

Demographic data

The average age of the participating dentists amounted to 47.8 (± 11.6) years, and the time since graduation was about 20.2 (± 11.5) years. Most dentists worked in group practices (57.9%); 38.5% of dentists were active in single practices and 2.5% at universities. One percent declared that they worked both at a university and in a private office. Among the responding participants, 65.8% worked independently and 32.4% were employed. A combination of both forms of employment was indicated by 1.5% of the interviewees.

Most dentists (52.4%) worked in big cities (>100,000 inhabitants), 24.1% in rural areas, and 22.3% in smaller cities. SSO members constituted 79.2% of the respondents. Thirty-two percent of the participants indicated at least one occupational focus. Most frequently mentioned were reconstructive dentistry (specialized dentist for reconstructive dentistry SSO/SSRD; 23.8%), implantology (23.1%) as well as pediatric dentistry (15.0%).

Frequency of repairs

The evaluation of the questionnaires revealed that the implementation of repair restorations depends on the material of the original restoration: composite restorations are repaired most frequently (98.5%), indirect metallic and amalgam restorations most rarely (54.6% and 51.5%, respectively). When related to the material of the original restoration, the frequency of repairs for the most part differs significantly (Fig. 1). The factors age, gender, occupational focus, and SSO membership of the dentists as well as the type and location of the practice only partially exerted a significant influence on the percentage of repair restorations accomplished (Tab. I). Overall, only one of the questioned dentists indicated to principally refrain from making repair restorations. Dentists who stated at least in one

instance that they rarely or not at all repaired restorations made of a particular material, justified this with own bad experience (20.4%), insufficient training (11.0%), bad experience of other dentists (6.3%), or missing knowledge regarding the necessary conditioning of surfaces to be treated (3.7%).

Reasons for the implementation of repair restorations

As reasons for repairs of dental restorations were mentioned mainly the reduction of treatment costs in comparison with a newly made restoration (79.3%), a prolongation of the lifespan of the restoration (77.7%) as well as the conservation of dental hard tissue (75.3%). However, patients' requests (62.6%), fabrication as a temporary measure (44.2%), and time saving (26.6%) were also indicated as possible reasons. On the other hand, compliance with the warranty period, stated in 5.7% of the responses, played an only inferior role.

Decision criteria for the evaluation of maintainability

The size of the defect was mentioned by 89.8% of the questioned dentists as a decision criterion for the implementation of a repair. The maximum repairable defect size was estimated at about 30.4% ($\pm 14.8\%$). In addition, further tooth- and restoration-related factors such as the type of material (84.1%), the extension (63.1%) and the age (45.5%) of the original restoration, the localization of the defect (e.g. palatal or approximal; 36.5%), and the type of tooth affected (19.3%) were listed as well. Thus 97.8% of all dentists would carry out repairs of restorations in molars. In contrast, restorations of premolars and front teeth would be repaired by only 73.1% and 5.4% of respondents, respectively. The question whether the original restoration had been made by themselves or a different professional was considered relevant for decision making by only 12.7% of the interviewed dentists.

Indications for the implementation of repair restorations

Main indications for the implementation of repairs with the various restorative materials are the partial loss of a restoration (22-80%), loss of dental hard substance adjacent to a restoration (33-75%) as well as the restoration of an access cavity following an endodontic treatment (56-75%). Furthermore chipping of veneers (38-

67%), marginal gaps (18-64%), secondary caries (23-57%), adjustments of color and shape (2-48%), and marginal discolorations (3-44%) were mentioned (Tab. II).

Clinical procedure related to repair restorations and materials used

For the implementation of repair restorations, composite is used most frequently (Tab. III). However marked differences could be noted regarding conditioning of the restoration surface (Tab. IV). In total, 86.7% of respondents indicated interest in learning adequate methods for the repair of restorations.

Patient acceptance and dentists' rating of the lifespan

Patient acceptance was assessed indirectly based on the responses of the interviewed dentists. Only 9.7% stated that their patients refuse repairs and rather request a new restoration. Thirty-two percent of the dentists indicated that their patients only want repair restorations, if the durability of these is comparable to that of a new restoration. Fifty-eight percent noted that repair restorations are also requested, if in comparison with a new restoration, a shorter lifespan has to be expected.

The appreciation of dental repairs was also high among the dentists: only 3.7% view repair restorations as merely temporary measures. Most dentists (75.8%) rate repair restorations as permanent restorations, which in comparison with newly made restorations exhibit a shorter lifespan. Twenty-one percent assessed the success rates of repair restorations and newly fabricated restorations as comparable.

Discussion

The survey among the dentists of the Canton of Zurich (Switzerland) has shown that the repair of partially insufficient restorations constitutes an established treatment concept, although composite and ceramic restorations are repaired much more frequently than crowns, indirect metallic restorations, and amalgam fillings. About half of the respondents declared that they never repair amalgam fillings and indirect metallic restorations. Defective restorations with functional failure patterns (e.g. fractures) are repaired more frequently than restorations with secondary caries. These results most closely correspond to the findings of a comparable study from Germany (KANZOW ET AL. 2016a). When considering exclusively the results regarding

the repair of defective composite restorations, there is also close agreement between the data presented here and those collected in Norway (STAXRUD ET AL. 2016) and Germany (KANZOW ET AL. 2016a): Only a very small proportion of respondents indicated that they principally did not repair composite restorations (Switzerland, Canton of Zurich: 1.6%, Norway: 0.3%, Germany: 6.6%).

The reserved attitude of dentists regarding the repair of indirect metallic restorations and amalgam fillings on the one hand can be accounted for by the fact that these are more conspicuous than tooth-colored restorations and, hence, a complete replacement of the partially insufficient restoration could be indicated for esthetic reasons as well. Moreover, concerns regarding potential health risks emanating from amalgam could also entail the decision to completely replace defective amalgam fillings (GORDAN ET AL. 2014). Restorations with secondary caries are probably more rarely repaired than restorations with fractures of the restorative material or the adjacent dental hard substance because there is fear that an undermining spread of the (secondary) caries cannot be fully controlled, if parts of the restoration are left in place. As a consequence, defective restorations with potential secondary caries probably are more often replaced completely (KANZOW ET AL. 2016a).

Regarding the necessary surface conditioning for an adequate bonding between composite and repair material, there is close agreement between the data of the present study and previous surveys (Tab. V). Apart from the procedures enabling a mechanical conditioning of the surface to be repaired and the utilization of an adhesive system, dentists in the Canton of Zurich (Switzerland) very often apply a silane as well. This approach fully conforms to the clinical treatment recommendations of HICKEL ET AL. (2013).

Most respondents rate the lifespan of repairs as lower than that of newly made restorations. This assessment is confirmed by the findings of a current review work showing that yearly failure rates of composite (0-5.7%) and amalgam repairs (0-9.3%) exceed those of newly placed restorations (composite: 0-1.8%, amalgam: 0-3.7%; KANZOW ET AL. 2016b).

Overall the survey can be considered representative. The response rate of the questionnaires is very well comparable to that of similar survey studies (HEAVEN ET AL. 2013, KANZOW ET AL. 2016a, KOPPERUD ET AL. 2016, STAXRUD ET AL. 2016), although no expense allowance was granted and no reminder could be send due to the anonymous interview. Also the demographic data revealed by the member

statistics of the Canton of Zurich (registered dentists on March 1, 2016: 57% males, 43% females, age: 47±12 years) are excellently reflected by the survey (59.0% males, 40.9% females, age: 47.8±11.6 years).

On closer consideration of the demographic factors we could not, however, detect a clear association with the attitude of dentists toward repairs and, therefore, identify a "typical" dentist with a preference for repair restorations. This agrees with findings from other studies (KANZOW ET AL. 2016a, STAXRUD ET AL. 2016), although in the literature correlations between therapy decisions and demographic factors are sometimes described (VIDNES-KOPPERUD ET AL. 2009, RILEY ET AL. 2011, GORDAN ET AL. 2012, KAKUDATE ET AL. 2012).

In summary, it can be concluded that in Switzerland (Canton of Zurich) repairs of single-tooth restorations are frequently made and essentially rated positive. The indication for the implementation of repair restorations and the clinical procedure largely correspond to the outcomes of similar studies in Norway and Germany.

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Résumé

L'objet de cette étude était de mener un sondage représentatif concernant la réalisation et la pratique des réparations de restaurations unitaires parmi les dentistes du canton de Zurich. Un questionnaire anonyme a été envoyé à 1411 dentistes inscrits; 38,9% des questionnaires ont été retournés dont 35,3% ont été évalués. L'analyse statistique a été effectuée avec le coefficient de corrélation par rangs de Kendall's Tau, le test de rang de Wilcoxon ainsi que le test de Kruskal-Wallis ($p < 0,05$). Les réparations d'obturations sont souvent faites (composite: 98,5%, céramique: 88,9%, couronnes: 86,5%, métal: 54,6%, amalgame: 51,5%). Les causes mentionnées le plus fréquemment pour effectuer les réparations de restaurations sont la perte partielle d'une restauration existante ou de la structure de la dent

avoisinante tandis que les restaurations de caries secondaires sont moins souvent réparées. La décision de réaliser une réparation d'obturation dépend principalement de la taille du défaut (90%) ou de la taille de la restauration (63%) aussi bien que du matériel de la restauration initiale (84%). Le matériel le plus couramment utilisé pour la réparation après conditionnement approprié est le composite. La plupart des dentistes estiment que la longévité des restaurations de réparation est inférieure à celle des restaurations nouvellement effectuées. En résumé, les réparations des restaurations unitaires défectueuses sont fréquemment effectuées par les dentistes dans le canton de Zurich et représentent une méthode de traitement bien établie.

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Legends

Fig. 1 Repairs of single-tooth restorations made of various restorative materials and crowns. Diverse superscript letters denote a significantly different distribution of repair percentages.

Tables

Tab. I Significance (p-values) of the effects of various demographic parameters on the frequency (never 0%, occasionally <10%, sometimes <50%, and frequently >50%) of repairs carried out					
	Repair restorations of				
	Amalgam	Composite	Ceramic	Metal	Crowns
Age	0.622	0.061	0.746	0.026*	0.038*
Gender male/female	0.513	0.563	0.077	0.115	0.004*
Office location rural/city/big city	0.903	0.086	0.505	0.839	0.688
Form of practice single practice/group practice/university	0.344	0.329	0.355	0.779	0.581
SSO-membership yes/no	0.027*	0.795	0.561	0.003*	0.372
Occupational focus yes/no	0.003*	0.019*	0.014*	0.010*	0.012*
<p>* = significant effect Age: Indirect metallic restorations and crowns are more frequently repaired by older dentists ($\tau=0.08$ and $\tau=0.07$, respectively). Gender: Indirect metallic restorations are more frequently repaired by male than female dentists. SSO membership: Amalgam and indirect metallic restorations are more frequently repaired by SSO members than non members. Occupational focus: Composite restorations are more frequently repaired by dentists with an occupational focus, all other restorations more frequently by dentists without an occupational focus.</p>					

Tab. II Percentage of various indications for the implementation of repairs				
	Repair restorations of			
	Amalgam (%)	Composite (%)	Ceramic (%)	Metal (%)
Partial loss of the restoration	39.8	80.1	65.6	21.6
Adjacent loss of dental hard substance	38.2	74.5	51.2	32.6
Secondary caries	23.4	57.3	43.2	31.7
Color or shape adjustment	2.1	48.4	8.1	2.1
Marginal gap	18.0	64.4	41.1	26.3
Marginal discoloration	3.1	44.3	21.6	5.2
Chipping of a veneer	-	-	66.6	37.6
Restoration of an endodontic access cavity	-	-	74.5	56.2
Multiple answers were possible.				

Tab. III Percentage of restorative materials used for repairs

Repair material	Repair restorations of			
	Amalgam (%)	Composite (%)	Ceramic (%)	Metal (%)
Amalgam	6.6	0.0	0.8	3.3
Composite	62.1	98.4	90.7	70.3
Cement	5.6	2.5	2.7	7.8
Other	0.2	0.2	1.8	0.8

Multiple answers were possible.

Tab. IV Percentage of measures and materials applied with repairs				
	Repair restorations of			
	Amalgam (%)	Composite (%)	Ceramic (%)	Metal (%)
Surface cleaning	41.3	69.5	58.9	39.0
Creation of macroretentions	44.0	47.2	24.0	36.4
Roughening with diamond	36.2	75.7	61.0	38.4
Application of phosphoric acid	15.7	57.5	18.8	14.7
Application of hydrofluoric acid	-	-	77.5	-
Sandblasting	14.3	37.3	36.2	29.1
Application of a silane solution	17.6	70.3	77.7	34.3
Application of an adhesive system	39.0	93.0	76.4	45.0
Opaque	4.5	9.3	14.0	21.5
Other	0.4	4.0	0.8	1.0
Multiple answers were possible.				

Tab. V Percentage of measures and materials applied for conditioning of a composite restoration in preparation for repair. Comparison of data from different countries or studies

	Canton of Zurich (this study) (%)	Norway (STAXRUD ET AL. 2016) (%)	Germany (KANZOW ET AL. 2016a) (%)
No conditioning	1.2	2.0	0.4
Creation of macroretentions	47.2	79.8	35.8
Application of phosphoric acid	57.5	82.3	67.3
Application of an adhesive system	93.0	83.3	93.6
Application of a silane-solution	70.3	7.4	17.5
Multiple answers were possible. Individual studies partly inquired about further possibilities of conditioning, which for the benefit of better comparability are not listed here.			