

Dental Technicians' Experiences with All-Ceramic Extra-Coronal Restorations

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Abstract - *The aim of this study was to identify the dental technicians' experiences with extra-coronal all-ceramic restorations. A questionnaire was mailed to all laboratories registered in The Norwegian Association of Dental Laboratory Owners (n=186). The response was 149 (80%). All-ceramic restorations were produced by 93 (62%) of the responding laboratories. A few of these (17%) produced the majority (67%) of the restorations. The dental technicians reported low rates of remakes (median 2%) for all-ceramic restorations. The low production and the limited number of laboratories that perform this work show that there is room for extended training and more expertise in this field.*

KEY WORDS: Dental technology; Ceramics; Prosthodontics; Remakes; Census survey.

INTRODUCTION

Ceramic materials have been used for teeth restoration for a long time¹. Technological advances have enabled dental technicians to employ new methods in the production of all-ceramic restorations^{2,3}. The materials have also undergone a massive development. New improved materials are frequently introduced and each material requires specific handling procedures. The technicians have to learn new methods for handling these materials and dentists too, need to keep up with the rapid development. Mistakes in all parts of the production chain can easily reduce the quality of the restorations. Norway is a country with a high density of dentists per inhabitants (1 per 10000) and a high proportion of the population visits the dentist regularly⁴. Each patient uses an amount of money equivalent to approximately 350 US dollars a year on dentist fees. Nowadays, amalgam is used to a very limited extent in Norway and is being replaced by more esthetic restorations⁵. We do not know how this has affected the use of all-ceramic prosthetic restorations.

The aim of the present study was to identify the different ceramic materials and production techniques used in Norway. Furthermore, we wanted to investigate the frequency of and reasons for remakes of extra-coronal all-ceramic restorations as experienced by dental technicians.

MATERIALS AND METHODS

A questionnaire was sent to the managers of all dental technology companies registered in The Norwegian Association of Dental Laboratory Owners. The association includes approximately 75% of the dental laboratories in Norway. The non-respondents were contacted and a second questionnaire was sent if necessary. From a total of 186 contacted firms, 149 (80%) responded. Ninety-three questionnaires were returned completed, while 56

companies reported that their production of all-ceramic restorations was very low or non-existent. These 56 companies were therefore excluded from the study. The questionnaires were anonymous and all envelopes were disposed of before registration. All analyses were based on the results of the 93 completed questionnaires.

The questionnaire consisted of two main parts. The first part contained questions about the materials and methods of production used by the laboratory. The second part included questions about frequency of and reasons for remakes. All information pertained to units delivered in the previous year. "Remakes" were defined as restorations that had failed for some reason and had to be produced a second time.

Most questions were pre-coded, but two questions required respondent-formulated answers. One of the open ended questions covered the same information as one of the pre-coded ones. This was used as a control of the reliability of the pre-coded answers. The statements given in the respondents' own words were coded into categories in order to facilitate the analyses. The coding was done twice by the same operator on two occasions separated by 2-5 months. In the situations where the two coded results differed, a second examiner was consulted and the joint decision registered.

When asked to formulate an opinion about all-ceramic materials at their own laboratory, the technicians wrote one or more comments. Two or more positive statements were coded as "very positive", one positive statement became "positive", neutral or both positive and negative statements became "neutral" while a negative statement was coded as "negative" and several negative statements as "very negative". The results from the two coding sessions showed differences in 18 percent of the cases, but never by more than one factor (Cohen's Kappa value=0.79). When asked to give an opinion of what they believed was the main reason for remakes of all-ceramic restorations, the dental technicians wrote one or several suggestions. These answers were categorized as: "insufficient preparation/impression", "unsatisfactory cementation", "fractures", "color

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mismatch", or "not specified". The registered results from the two coding sessions showed differences in 5 percent of the cases (Cohen's Kappa value=0.92).

The data files were proofread once. Frequency distributions were computed and the strength of the relationship between two variables assessed using the Spearman correlation coefficient. Tests resulting in p-values below 5 percent were considered significant. The statistical analyses were performed using SPSS (12.0).

RESULTS

Materials and production methods

A variety of materials were reported used for all-ceramic restorations. In most cases the laboratories used one or two different materials and production techniques for each type of restoration, but some used up to five materials for each category. The majority (90%) of the responding dental technicians were "satisfied" or "very satisfied" with the materials they used. The choice of material used in each individual case was a joint decision by the dentist and the technician in 54 percent of the cases. In the remaining situations, the dentists decided in 27 percent of the cases and the technicians in 19 percent.

The most common methods for producing veneers and single layer crowns among the Norwegian technicians were hand-condensing and sintering or pressing (Table 1). The preferred methods for producing all-ceramic core crowns were either computer-aided design/computer-aided

manufacturing (CAD/CAM) or pressing. Fixed partial dentures (FPDs)/ bridges were also pressed or produced by a CAD/CAM method. The most common CAD/CAM method used in Norway was the Procera system (Nobel Biocare AB, Gothenburg, Sweden) while the IPS Empress System (Ivoclar Vivadent AG, Schaan, Liechtenstein) was the most frequently used pressing system.

One fifth of the firms reported that they had CAD or CAD/CAM equipment, either alone, or in cooperation with others. Most had only a scanner, but 6.5 percent had milling equipment as well. Ten percent had used the machines for more than two years. Several replied that they had considered buying such equipment but added that the cost was too high.

Seventy percent of the firms practiced ordering of some all-ceramic products from other companies if they could not produce themselves. This practice mainly concerns alumina or zirconia cores which they individualized with veneering ceramic at their own laboratory, but some (8%) also ordered pressed ceramic cores or products ready for insertion.

Volume of production

The median number of all-ceramic crowns made in an average month was 11 (range 1- 400) (Figure 1). Summarized, the total production from all the respondents amounted to approximately 33 000 single unit crowns and 208 FPDs a year. A few laboratories (17%) produced the majority (67%) of the restorations. When taking into account that

Table 1. Frequencies of dental technology laboratories ($n = 93$) according to production methods and all-ceramic restorations. Many of the companies used more than one method.

Production method	Veneers	Single layer crowns	Anterior core crowns	Posterior core crowns	Anterior FPDs (bridges)	Posterior FPDs (bridges)
Traditional firing	52	41	--	--	--	--
Pressing/Casting	42	37	34	34	20	16
CAD/CAM	18	15	81	93	27	21
Other methods	0	0	1	1	0	0
No production	6	23	2	5	53	60

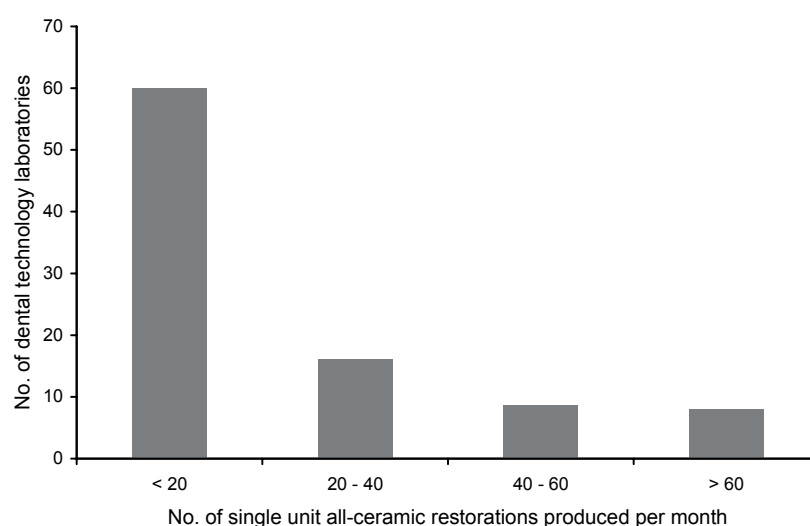


Figure 1. The distribution of dental technology laboratories producing all-ceramic restorations in Norway ($n = 93$) according to monthly production of all-ceramic single unit crowns.

this study includes 80 percent of the members of the union and that the union includes approximately 75 percent of all dental laboratories in the country, the total production in the country may be estimated. An estimate of the total annual production based on these results indicates approximately 50 000 all-ceramic units or approximately 12 units per year per Norwegian dentist.

Five percent of the respondents reported a reduction in the use of all-ceramic prosthetic restorations, while 62 percent stated that they had experienced a rise in the demand for these products.

Remakes

The companies reported the number of restorations needing to be remade relative to those submitted for the previous year. A remake proportion of 3 percent or less was reported by 60 percent of the respondents. The median value was 2 percent (range 0-30). Of the companies reporting a remake percentage of 5 percent or more, all but two made less than 20 units a month. However, no statistically significant correlation between the number of units produced and the rate of remakes was found ($r^2=0.021$; $p=0.850$).

The dental technicians claimed that the main reasons for remakes of all-ceramic restorations in general were inadequate preparation/impression, insufficient cementation/bonding and fractures (Figure 2). Specified for the different categories of restorations, the reasons for remakes showed some variation (Table 2).

Anterior crowns (17%) were more often subject to color mismatch than posterior crowns (9%) and veneers were the restoration type most susceptible to loss of retention (14%). The dental technicians with the highest remake percentage reported the same variation in their opinions regarding the main reason for remakes as the rest of the respondents.

Experience

The technicians were asked to give their opinion on the use of all-ceramic materials in their own laboratory. One or more positive statements were given in 62 percent of the cases. Examples of these statements were "good aesthetics", "good economy", "easy handling" and "the materials of the future". However, 8 percent reported some problems associated with the use of these materials. Examples of negative statements were "low profit", "too many fractures" and "demanding procedures". There was a highly significant correlation between these results and the reported satisfaction given with tick-off answers later in the questionnaire ($r_s=0.45$; $p < 0.001$). The reported satisfaction did not, however, correlate significantly with the rate of remakes ($r_s=0.08$; $p=0.509$). Several technicians requested more and better courses and many wished to make more all-ceramic restorations in the future.

DISCUSSION

The results from this census survey show that the overall production of all-ceramic restorations in Norway was

Table 2. Distribution of the most frequently reported causes for remakes of all-ceramic restorations. The results are pooled from the most commonly and the second most commonly reported reasons for remakes from the Norwegian dental technology laboratories ($n = 93$).

Causes of failure	Veneers	Single layer crowns	Anterior core crowns	Posterior core crowns	Anterior FPDs (bridges)	Posterior FPDs (bridges)
Unsatisfactory preparation	18	14	23	19	5	6
Fracture of veneering mat.	20	22	24	24	6	6
Fracture of core mat.	4	5	25	25	8	7
Colour mismatch	17	15	17	9	5	2
Loss of retention	14	4	6	2	1	0
Misfit	11	8	9	13	1	0
Unsatisfactory occlusion	8	7	10	15	2	3
Other factors	3	1	4	3	0	1

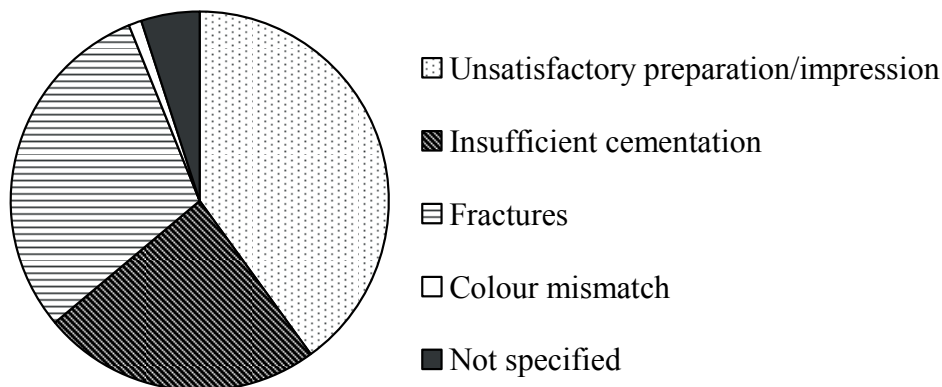


Figure 2. The main reasons for remakes of all-ceramic extra-coronal restorations as experienced by Norwegian dental technicians.

low. The majority of the restorations were produced by a minority of the dental laboratories. The technicians were apparently content with the ceramic materials, since the majority was satisfied or very satisfied with the materials they used. Most companies experienced an increase in the demand for all-ceramic restorations.

Traditional hand-condensing and pressable/castable ceramics were the most common methods used for making veneers and single layer ceramic crowns. Core materials in alumina/zirconia produced with CAD/CAM technology and pressed ceramics were most common for crowns and FPDs both in the anterior and the posterior region. Few companies made fixed partial dentures, and the overall number of such restorations produced each year was low. Ordering all-ceramic cores or restorations from other companies was common practice.

Factors in the dentists' part of the handling process were more frequently mentioned as what the dental technicians regarded as the main causes for remakes than factors in the technicians' procedures. These findings are comparable with another study indicating that some dentists have limited knowledge of the preparation criteria for all-ceramic restorations⁶. This may be due to the limited teaching of all-ceramic restorations in Scandinavian dental schools until recently⁷. The same may be the case regarding the success of veneers and adhesively bonded all-ceramic crowns which is determined by the strength and durability of the adhesive bond to the tooth surface⁸. However, similar questions would probably have generated quite different results if dentists were asked. It is obviously not easy for a dental technician to evaluate which factors lead to failures of a restoration. Their knowledge is limited to the information given by the complaining dentist.

It is difficult to verify the reasons for failures on the basis of published clinical studies, as these mostly report only survival rates or the number of lost restorations and seldom make detailed technical analyses of the reasons for failures⁹⁻¹³. The most common reasons for remakes reported in this study are similar to those in several other studies^{8,14-16}. There was no significant correlation between the number of units produced and the rate of remakes in this study, even though almost all the laboratories with remake rates of more than five percent produced less than 20 all-ceramic units a month. We had expected to find that laboratories with a large production of all-ceramic restorations reported lower rates of remakes than others because of more experience. However, this could not be confirmed by the present study.

The rate of remakes was very low. It is possible that managers have underreported the true values and it is likely that dentists do not report all failures to the technicians. However, it is reasonable to presume that the technicians have been honest when reporting their views on these materials. It would not be in their interest to use materials that were clinically inadequate, as this would eventually reflect on their business and profit. It is also possible that there have been different ways of interpreting a "remake". Some may have reported corrections in color and occlusion while others only reported total remake. The rate of remakes, however, corresponds with several published clinical studies of all-ceramic restorations^{9-11, 17-23}. Nevertheless, failures in clinical studies are not always related to

material insufficiency or technical complications and the reported rates may not be directly comparable²⁴.

CONCLUSION

The findings of this study indicate that all-ceramic restorations do not have a prominent place within Norwegian dental technology, but some laboratories seem to have built up special competence within this area. Traditional hand-condensing with feldspathic ceramics and pressing/casting glass ceramics are the most common ways of making veneers, while all-ceramic single unit crowns are most commonly processed with a high strength ceramic core and veneered with feldspathic porcelain. Advanced technological methods for producing all-ceramic restorations are commonly used. The production of fixed partial dentures in all-ceramic materials is limited.

The technicians are very satisfied with the materials they use and reported an overall low remake rate, as well as an increase in the demand for all-ceramic restorations. The dental technicians suggest that procedures performed by the dentists are the strongest determinant for the success of all-ceramic restorations.

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