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ORIGINAL ARTICLE

Compliance of dental laboratory technicians with dentists' instructions for fabrication of a PFM crown

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KEYWORDS

Lab-technician compliance;
Dental laboratory communication;
Laboratory work authorization

Abstract *Objectives:* The aim of this study was to evaluate the compliance of dental technicians from different dental laboratories with dentists' written prescriptions during fabrication of porcelain-fused-to-metal (PFM) crowns.
Materials & methods: Final impressions for a prepared Ivorine tooth no. 21 were sent to 16 dental laboratories (8 government and 8 commercial) for fabrication of a PFM crown. A detailed, standard work authorization form accompanied each case, including a request to fabricate a uniform-thickness metal framework, with incisal translucency, hypocalcification-like stain, porcelain facial shoulder and metal palatal chamfer margins with palatal occlusion in porcelain. All crowns were then collected, and data were recorded and analyzed statistically with Fisher's Exact and Pearson's Chi-square tests by means of SPSS and WinPepi software.
Results: No statistically significant differences were found between laboratory groups in following the instructions for metal substructure thickness ($P > 0.6$), facial and palatal margins ($P = 1.0$) or the dimensions of the hypocalcification-like stain ($P = 0.28$). However, commercial labs were significantly better than government labs in the location criteria for hypocalcification and incisal translucency ($P = 0.04$). When the total numbers of successfully followed criteria were compared, commercial labs were found to be significantly better than government labs in following the written instructions ($P = 0.002$).
Conclusion: Although a standard work authorization form was used, commercial labs performed better than government labs, especially in esthetic characterizations such as hypocalcification-like staining and incisal translucency.

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1. Introduction

Success in providing a dental patient with a quality dental prosthesis depends on multiple factors related to the dentist, the laboratory technician or both.

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Effective and clear communication between the dentist and dental technician plays an important role in providing the patient with a quality prosthesis.[1] The importance of this communication has been well-documented in the literature.[2–5]

Lack of communication has been considered to be a major factor in failure to provide the patient with optimum dental services.[6,7]

The British Society for the Study of Prosthetic Dentistry (BSSPD) stated that restorative work involving technical procedures requires a close relationship between the clinician and the dental technician, beginning with discussion of the proposed design. For this to happen, both the clinician and the dental technician must be proactive and prepared for effective communication to take place.[8] Laboratory prescriptions are important tools in this communication.

In addition to improving the quality of the restoration, a clear prescription for fabrication of a dental prosthesis helps avoiding unnecessary delays and remakes, therefore saving time for all parties involved in the dental treatment procedure.[9,10]

Different communication methods during the early phases of dental prosthesis fabrication can be beneficial. However, personal contact between the dentist and the lab technician is considered to be one of the best communication methods.[11]

During fabrication of a porcelain crown, successful reproduction and matching of esthetic details, such as hypocalcification or translucency, are important for achieving an esthetic restoration. Errors in matching these details may result in patient dissatisfaction.[12]

Several studies and surveys have been conducted to evaluate the quality of written prescriptions and communications between dental clinicians or students and the laboratory technician.[9,13–16] However, the degree of laboratory technicians' compliance with detailed authorized instructions for the fabrication of a dental prosthesis has not been fully investigated.

The purpose of this study was to evaluate the performance of different government and commercial dental laboratories in following written prescriptions for the fabrication of a PFM crown and to compare the results of the dental-school-based laboratories with those of other dental labs.

The null hypothesis was that there would be no significant differences between government and commercial laboratories in following the instructions provided for the fabrication of a PFM crown.

2. Materials and methods

In this study, 16 dental laboratories (8 government and 8 commercial) were included. The 8 commercial labs were randomly selected from different parts of Riyadh city. Six government labs were from different military and health sectors, and 2 were school-based dental labs. Tooth preparation for a PFM crown on a maxillary left central incisor (Ivorine tooth no. 21) mounted on a dentoform jaw model (NISSIN Dental Products Inc., Kyoto, Japan) was performed with the following dimensions: about 1.5 mm facial reduction in 2 planes, 1.0 mm palatal reduction and 2.0 mm incisal reduction with facial shoulder margins and palatal chamfer margins.[17]

The prepared tooth no. 21 in the dentoform jaw model was then unscrewed and fitted into the socket-like hole for tooth no. 21 on a study cast model for a simulated patient. The prepared Ivorine tooth was glued after being oriented to be in the same alignment as the rest of the anterior teeth on the study cast.

Sixteen final impressions, in a light- and heavy-body polyvinyl siloxane impression material (Aquasil, Dentsply, York, PA, USA), in plastic full-arch trays were then taken for the master cast. Quality of the impressions was carefully inspected by means of a 2.5X magnification loupe. Impressions were sent to the laboratories on the same day the final impressions were taken, along with the opposing casts and bite records (Occlufast, Zhermack, Italy) and standard work authorization forms including the order for the impression to be poured in a die stone to fabricate a working cast model, followed by pindexing, die trimming, waxing and casting of the metal substructure with a thickness of 0.3–0.5 mm.

The metal frameworks were measured at 6 points (Fig. 1) by means of a sharp-end stainless steel measuring gauge (Patterson Iwanson Spring Caliper, Patterson Dental, Saint Paul, MN, USA). Each metal substructure was divided into equal thirds: cervical, middle and incisal. On each third, mesial and distal measurements were performed, and recorded for each received crown. Metal frameworks were then returned to the laboratories for porcelain application with universal shade map, in addition to the following specific instructions which were attached to the work authorization form:

- Hypocalcification-like spot of 1.0 mm wide and 2.0 mm high in the distal-incisal angle.
- 1.0 mm wide incisal translucency.
- Facial porcelain shoulder margins.
- Palatal (lingual) metal chamfer margins.
- Palatal (lingual) occlusion on porcelain.
- Final glazing for the finished crown.

Crowns were then collected, and a number was randomly assigned to each case. Each crown was evaluated anonymously for the compliance of the lab technician with the requested written instructions. The criteria evaluated for compliance were:

Fig. 1 Metal framework with six-point measurements, two on each third.

1. Metal substructure thickness on the cervical, middle and incisal thirds
2. Incisal translucency presence and dimension
3. Facial porcelain margins
4. Palatal metal margins
5. Occlusion on porcelain
6. Hypocalcification-like location
7. Hypocalcification-like dimension
8. Final glazing

The dimensions of the translucency and the hypocalcification-like spots were measured, in mm, by means of a periodontal probe (Williams Probe, Hu-Friedy, Chicago, IL, USA).

All measurements and evaluations were independently performed, and repeated twice, by two pre-calibrated dental practitioners, under 2.5X magnification loupes, in a dental clinic and consensus was forced when disagreement occurs. Results were recorded for each criteria as whether following or not following the instructions.

Data were collected and analyzed statistically with SPSS version 20.0 software for cross-tabulation analysis for comparison of proportions for each parameter between government and commercial labs by means of Fisher's Exact test.

WinPepi software, version 11.62, was also used for cross-tabulation analysis for comparison of proportions of all parameters combined between government and commercial labs by Pearson's Chi-square test.

All results were analyzed at a significance level of 0.05.

3. Results

3.1. Metal substructure

Seven laboratories (44%), 3 government and 4 commercial, fabricated metal substructures with the required thickness in all thirds. However, no statistically significant difference was found between the two laboratory groups in matching all thirds or each individual third ($P > 0.6$).

Fig. 2 shows a comparison between the laboratory groups in following the instructions for the metal substructure thickness in each individual third.

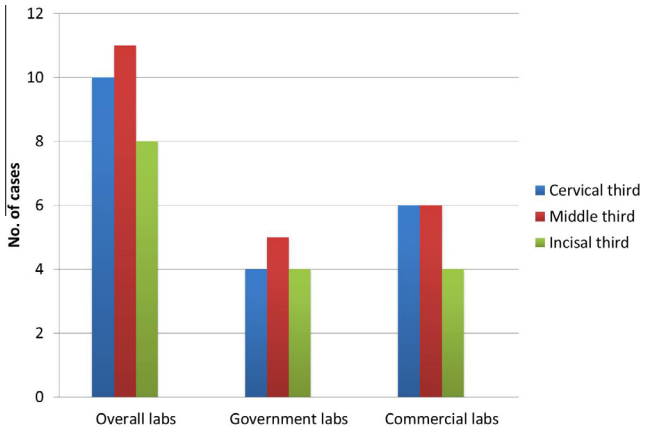

Fig. 2 Number of cases successfully matching the requested metal thickness in all thirds.

3.2. Hypocalcification-like spot

Only 5 laboratories (31%), 4 of them commercial, produced the requested hypocalcification-like spot with the desired location and dimensions. Two government labs made the hypocalcification-like spot but failed to achieve either the location or the dimensions (Fig. 3). The commercial labs performed significantly better than the government labs in meeting the location criteria ($P = 0.04$). However, no statistically significant differences were found between the groups in the dimension criteria ($P = 0.28$).

All labs that matched the hypocalcification dimensions were successful in matching the location criteria.

3.3. Incisal translucency

In total, for 7 of the 16 crowns (43.8%), the written instructions for translucency criteria were followed. Of these, 6 cases were commercial (Fig. 4). Seven labs (5 government and 2 commercial) returned the cases with translucency not following the width instructions, and 2 cases (all from government labs) did not meet the translucency criteria in their crowns. Commercial labs were significantly better than government labs in meeting the translucency criteria ($P = 0.04$).

3.4. Facial and palatal margins

For 12 crowns (75%), 6 government labs and 6 commercial labs followed the instructions for palatal margins, while only for 9 crowns (56.3%), 4 government labs and 5 commercial labs, the instructions were followed for facial margins. No statistically significant differences were found between government and commercial labs in the facial or palatal margins ($P = 1.0$).

3.5. Occlusion

All 16 crowns had occlusion in porcelain as was instructed.

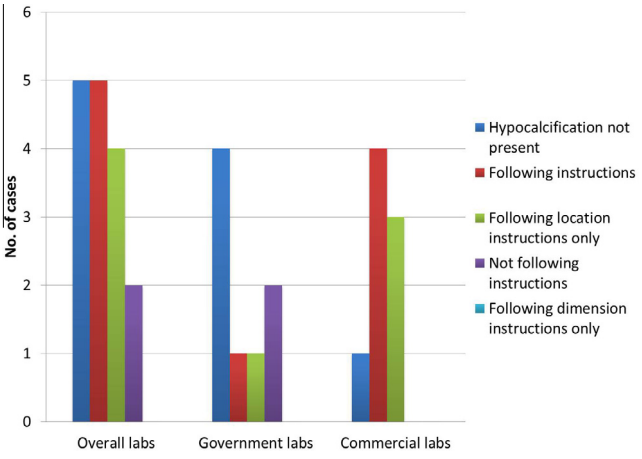

Fig. 3 Laboratory technicians' performances in meeting hypocalcification criteria.

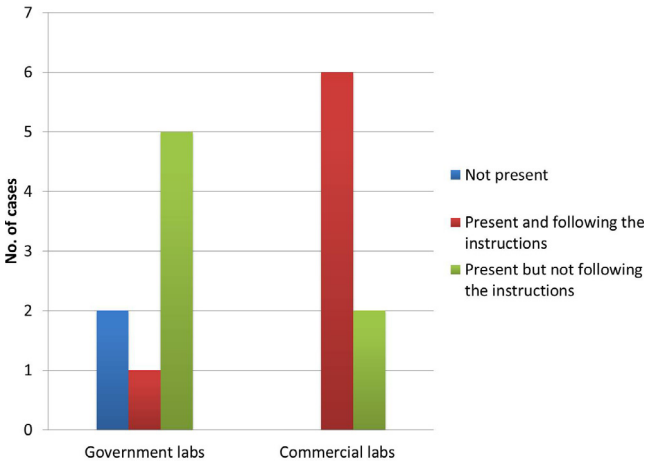

Fig. 4 Laboratory technicians' performance in meeting translucency criteria.

3.6. Glazing

All crowns were returned from the labs glazed except one case that was made by a government laboratory. Therefore, no statistically significant differences were found between the two groups ($P = 1.0$).

3.7. Overall summary

Laboratory groups were compared for the total number of cases where instructions were followed successfully (Figs. 5 and 6). The commercial labs were significantly better than the government labs in following the written instructions ($\chi^2 = 9.8382$, $P = 0.002$), with the results showing that commercial labs successfully followed 76.3% of the provided instructions compared with 52.5% by the government labs.

4. Discussion

In the present study, the compliance of 16 different dental laboratories with detailed written instructions for the fabrication of a PFM crown were evaluated. Communication with the laboratory technicians was solely through clear and informative written instructions, without verbal, personal, Web-based or any other forms of communication.

Several authors, societies such as the BSSPD and associations such as the American Dental Association (ADA) and the National Association of Dental Laboratories (NADL) have set guidelines and recommendations to improve the quality of the final products from dental labs by emphasizing the importance of good communication between the dentist and the laboratory.[5,18–22]

The European Union's Medical Devices Directive (93/42/EEC) states that "it is the responsibility of the dental practitioner to provide clear instructions for the production of a prosthesis by the dental technician, who should then produce the prosthesis to the required specification."[23–26]

Because there are no international guidelines for communication with the dental lab, delivery of the information between the dentist and the technician depends mainly on the laboratory policy and on the dental practitioners themselves.[16]

Some laboratories use their own forms to be completed by the dentist. However, others accept the work authorization forms that dental offices provide with the cases.

In this study, in addition to completion of the forms provided by some laboratories, universal written instructions were attached to all of the cases.

Fifty percent of the commercial labs and 37.5% of the government labs were able to fabricate metal substructures with the required thickness in all thirds. Fig. 2 shows that both lab classifications performed best in the middle third.

For hypocalcification, results revealed that 68.8% of the labs did not produce the hypocalcified-like area in the requested location and dimensions. Only one government lab

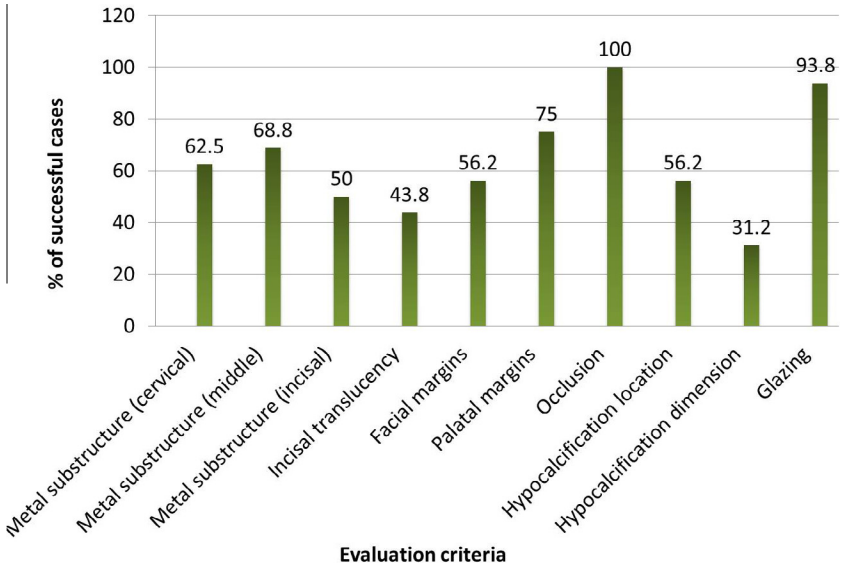

Fig. 5 Overall percentage of success of lab technicians in meeting each requested criterion.

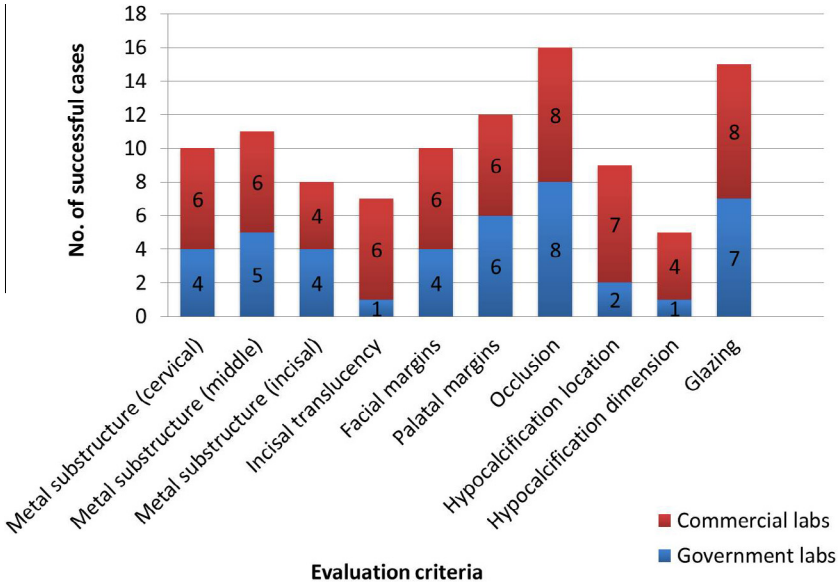

Fig. 6 Overall compliance of both laboratory groups in meeting each criterion.

successfully followed the instructions in terms of location and dimensions compared with 50% of the commercial labs that achieved this esthetic criterion according to the requested instructions. The difference between the two laboratory groups was clear and significant in the location criteria for the hypocalcification-like spot ($P = 0.04$), with 87.5% of the commercial labs making the requested criteria in the right location compared with only 25% of the government labs.

When the incisal translucency criteria were evaluated, the results showed that 75% of the commercial labs followed the instructions successfully. However, 25% succeeded in producing incisal translucency in their crowns but failed to follow the width instructions (about 1.0 ± 0.5 mm). For government labs, only one followed the written instructions precisely; however, 62.5% produced the translucency but did not achieve the required thickness, while the rest (25%) failed to add translucency to their crowns (Fig. 4). In this criterion, the difference between lab groups was clear and therefore significant ($P = 0.04$).

These results make commercial labs significantly better than government labs in producing small esthetic details like incisal translucency and white hypocalcified-like spots.

Both commercial and government labs succeeded in producing palatal contacts in porcelain, since both groups returned the cases matching the required criterion. However, the situation was different for the facial and palatal margins criteria, since 50% of the government labs left facial margins completely or partially in metal, compared with 25% of the commercial labs. Both groups performed almost equally well in the palatal margins section.

For glazing, all laboratories, except one government lab, returned the crowns glazed and ready for cementation. This may be explained by the preference of some laboratory technicians for trying-in the crown before cementation, to make final adjustments before glazing. However, the instructions were clear for all labs to return the crowns glazed and ready for cementation.

In summary, commercial laboratories did significantly better than government laboratories in following the instructions ($P = 0.002$). Therefore, the null hypothesis, that there would be no significant differences between the government and commercial labs in following the instructions, can be rejected. However, for each individual criterion, the null hypothesis cannot be rejected ($P > 0.05$) except for hypocalcification location and incisal translucency, where commercial labs performed significantly better than government labs ($P = 0.04$). Hypocalcification dimension was the least-followed criterion, since only 31.3% of the total 16 crowns had hypocalcification-like spots with the requested 1.0 mm dimension (Fig. 6).

Two of the government laboratories were school-based, the performance of which was comparable with that of other government labs (Fig. 7) and was less compliant than the majority of the commercial labs. However, the small size of the school subgroup should be taken into consideration, which may not reflect the actual performance of this group of lab technicians.

This may be explained by the deficiency of appropriate training for the dental students and school laboratory technicians in effective communication, as concluded in a survey study conducted by Juszczyk et al. in the United Kingdom.[15]

Therefore, the laboratory technicians may lack the communication skills needed to produce a quality and esthetically pleasing prosthesis if the students were not trained to communicate with them.

In an educational institution, it is important to have well-trained laboratory technicians who know how to read and understand the work authorization forms and communicate efficiently with students and practitioners alike.

For a better understanding of dentists' instructions by laboratory technicians, and thus improved quality of the prosthesis, more forms of communication have been recommended, including verbal, personal or photographic communications.[15] Web-based communications can also be used to achieve satisfactory laboratory work.

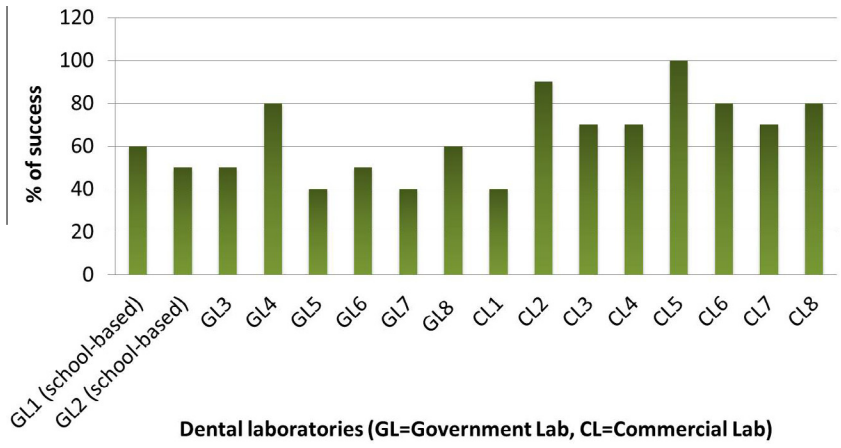

Fig. 7 Performance of the school-based labs compared with other labs.

Although, the results reported in this paper elaborate some differences in the performance of different laboratory technicians in following the dentist's instructions to fabricate a PFM crown, it's worth mentioning that one of the limitations of this study was the small sample size. More crowns made by every single lab can enhance the accuracy and reliability of the results. However, difficulties in accessing some dental laboratories, especially the military-sector labs, in addition to the time constraints, and their strict regulations of processing prosthetic cases made it difficult to request for fabrication of more than one crown or process more than one case.

5. Conclusion

Within the limitations of this study, the following can be concluded:

1. The participating dental laboratories evaluated for compliance with certain criteria for the fabrication of PFM crowns, such as metal substructure thickness, incisal translucency, porcelain and metal margins and porcelain occlusal contacts, vary in degrees of following the written instructions.
2. Although the same detailed work authorization was sent to all laboratories, commercial labs did generally better than government labs.
3. School-based laboratories performed similarly to other government labs, and differences between the end-products of their crowns and those of commercial labs were clear in this study.
4. More efforts should be exerted to enhance the quality of government and school-based laboratories by educating and training both dental laboratory technicians and students.

Conflict of interest

The author of this article declares no conflict of interest.

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