Quality of prescription and fabrication of single-unit crowns by general dental practitioners in Wales

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SUMMARY The aim of this investigation was to describe the quality of prescription and fabrication of single-unit crowns by general dental practitioners in Wales. One hundred pre-piloted questionnaires were distributed to commercial laboratories in Wales with large catchment areas, and 20 pre-piloted questionnaires were distributed to the production laboratory at the Cardiff Dental Hospital. Information was collected relating to the quality of prescription and master impressions for single-unit crowns. One hundred and seven completed questionnaires were returned (response rate = 89%). Sixty per cent (n = 64) of questionnaires related to single-unit crowns being made in general practice under private funding arrangements, 30% (n = 32) were being made in general dental practice under National Health Service (public) funding arrangements and 10% (n = 11) were collected from the Dental Hospital. Polyvinylsiloxane impression material was used to record the master impression in all cases (n = 107). Plastic stock trays were used to make the master impression in 79% of cases (n = 85), metal stock trays were used in 19% of cases (n = 20) and special trays were used in 2% of cases (n = 2). Eighty-five per cent (n = 91) of master casts were considered to be adequate for crown fabrication. Less than 50% of written instructions (n = 52) were considered ‘clear’ and of sufficient detail to adequately specify the planned crown. In 21% of cases (n = 22), the technician had to contact the dentist for clarification of the design prior to making the crown. While the quality of impression making for single-unit crowns was of a reasonable standard, the quality of the accompanying written communication was poor and more than one-half of written instructions examined failed to meet the requirements of the European Union Medical Devices Directive.

KEYWORDS: crowns, quality, impression, instruction, general dental practice, medicolegal

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Introduction

Improved public awareness and changing attitudes towards dentistry have led to increased demand for high quality and durable restorations, which satisfy the aesthetic requirements of today’s society. With more adults now retaining their teeth until later years in life, the oral rehabilitation of adult patients is likely to involve more complex and extensive treatments than ever before (1–3). Crowns may be provided for patients to satisfy requirements of function, aesthetics or both (4). It is recognized that the quality of a crown, or any other indirect dental restoration, may be a reflection of the skills of both the dental practitioner and the dental technician, and the effective communication between them (5, 6). This has been affirmed in the European Union’s Medical Devices Directive (Directive 93/42/EEC), which 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 (6, 7). Notwithstanding this legalistic approach, it will be appreciated that the dental practitioner has an ethical obligation to prescribe a
suitable crown, which will not have a deleterious effect on the oral tissues (6, 8, 9). While the dental technician is an important member of the oral healthcare delivery team, they do not have the necessary skills or training in the diagnosis or prevention of oral pathological processes, such as dental caries or periodontal disease. The risk of poor communication of design information and effective devolution of the prescription process of a prosthodontic item, such as a crown, to a technician introduces the risk of producing a restoration that can cause harm to the patient (10).

Despite the ethical and legal responsibilities on dentists to prescribe and adequately communicate design information to the dental technician (7, 8), an array of studies exists which demonstrate concerns about the quality of this communication, particularly in relation to removable prostheses (5, 11–23). For example, an examination of the quality of communication of design features for cobalt–chromium removable partial dentures in Ireland found that 53% of written instructions received in the study did not include any design information (including specifying which teeth were to be replaced), and 5% of prescriptions requested the technicians to design the denture themselves (12). A further study demonstrated that the quality of master impressions supplied for fabrication of cobalt–chromium removable partial dentures was also poor: 54% of master impressions were made using a plastic stock tray and alginate, and one-fifth of master impressions were deemed not suitable for construction of a prosthesis (13). These findings echo similar examples of poor quality prescription and fabrication of removable partial dentures in the UK (5, 24). This phenomenon has also been noted in relation to complete dentures, with a consistent pattern being observed over the last 15 years (21, 22). Similar problems exist in relation to the prescription and fabrication of fixed prostheses. Carrotte et al. (25) found that the quality of impressions for anterior crowns in England was poor. This trend in relation to fixed prosthodontics was confirmed, even after the introduction of the Medical Devices Directive in the late 1990s. Lynch and Allen (14) examined written instructions for fixed prosthodontics in Ireland, and found that 55% of cases examined had poor or no written instructions. However, the problem of poor prescription and communication of design information is not limited to the UK or Ireland. Similar difficulties have been demonstrated in relation to a range of prostheses in countries such as Bahrain (11), Canada (18), the US (19), South Africa (20) and Sweden (21).

Dentistry in general dental practice in Wales, as in England, is funded from two main sources – one by the NHS, where patients pay subsidized fees with an additional payment coming from the government; the other being ‘private dentistry’ where dentists charge increased – or as some would argue, appropriate fees for treatment provided and these fees are paid directly by the patient or by private dental insurance companies. Previous NHS funding arrangements, which were based on a fee-per-item scale, have been, in the past, criticized as being inadequate and implicated in the phenomenon of poor quality prescription writing (5, 24). A ‘new contract’ was introduced for dentistry funded by the NHS in general dental practice in 2005. This moved the payment method away from the fee-per-item mechanism with the aim of improving the quality of care afforded to patients.

While many, though not all, of the studies relating to poor quality prescription and fabrication of prostheses cited above were performed prior to the introduction of the European Union Medical Devices Directive, little information exists on the provision of single-unit crowns since the introduction of the ‘new contract’/NHS funding arrangements for general dental practice in the UK. Therefore, the aim of this investigation was to examine the quality of written instructions and master impressions for single-unit crowns in general dental practice in Wales.

**Materials and methods**

One hundred pre-piloted questionnaires were distributed to 10 dental laboratories in Wales. In addition, 20 questionnaires were distributed to the ‘in-house’ dental laboratory at the Cardiff Dental Hospital to allow comparison of a general practice with a hospital environment. Only cases completed by undergraduate students were to be included in this latter sample. Instructions were given to participating laboratories to complete one questionnaire per master impression for single-unit crowns received. Laboratories were encouraged to consider impressions for single crowns rather than multiple crowns, and not to consider more than one impression from any individual prescribing dentist.
It was requested that all completed questionnaires be returned anonymously. No identification of the patient, dentist or laboratory was to be included in the completed questionnaire. Information requested included:

- the funding arrangements under which the crown was to be provided;
- the choice of impression material and tray used;
- the ‘disinfection status’ of the impression;
- the quality of the poured cast, availability of an opposing cast and the ability to articulate the casts;
- the quality of prescription for the crown including the clarity of written instructions, and design features specified (these were classified as: ‘clear’, ‘a guide’, ‘poor’, ‘none’ or ‘illegible’);
- if the technician needed to contact the dentist for clarification of the design;
- the amount of information included on the appearance of porcelain-fused-to-metal and all-ceramic crowns;
- the design of occlusal and palatal surfaces in porcelain-fused-to-metal crowns.

Data from the questionnaires received was entered onto a Microsoft Excel spreadsheet. Descriptive statistics are reported.

Results

A total of 107 completed questionnaires out of 120 were received (response rate = 89%), of these 96 were from commercial dental laboratories (response rate = 96%) and 11 were from the ‘in-house’ dental laboratory at Cardiff Dental Hospital (response rate = 55%). Of the 107 cases examined, 64 (60%) of the crowns were being provided privately, 32 (30%) were being provided with NHS funding, and 11 (10%) were provided at Cardiff Dental Hospital. Fifty-nine per cent of crowns (n = 63) were porcelain-fused-to-metal, 33% (n = 35) were all-ceramic and 8% (n = 9) were full-gold crowns.

Polyvinylsiloxane was used as the impression material for making the crowns in all 107 cases examined in this study. Plastic stock trays were used to make the master impression in 79% of cases (n = 85), metal stock trays were used in 19% of cases (n = 20), and special trays were used in 2% of cases (n = 2). All cases using metal stock trays were produced under private funding arrangements in general practice, while the two cases using special trays were produced in general practice under NHS funding arrangements. A more detailed breakdown of the choices of impression tray and funding arrangements is shown in Fig. 1.

Ninety-nine per cent (n = 106) of the impressions examined appeared to have been adequately disinfected. The only impression that failed to meet this standard was received by one of the commercial laboratories and was provided under NHS funding. The responding technician noted ‘there was blood on the impression’.

Eighty-five per cent (n = 91) of master casts were considered to be adequate for crown fabrication. When considered by funding scheme, 92% (n = 59) of privately funded cases, 75% of NHS funded cases (n = 24) and 73% of cases from the Dental Hospital laboratory (n = 8) were considered adequate. When asked to give reasons for rejecting the other 16 master impressions/casts as being unsuitable for crown fabrication, nine were rejected because of an impression fault such as: ‘air blow in impression’, ‘lack of material’ or ‘drag in impression’ while the other seven cases were rejected because of a problem relating to the preparation margins, for example: ‘no visible margins’, ‘poorly defined margin’. All of the 16 rejected casts were made from impressions recorded.

Fig. 1. Choice of impression tray and funding arrangements.

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using a plastic stock tray and polyvinylsiloxane impression material.

Casts of the opposing arch were available in 97% of cases (n = 104). Of the three cases with no opposing cast, one each came from private practice, NHS practice, and the Dental Hospital laboratory. However, respondents indicated that in all three cases, they proceeded to fabricate a crown.

Where an opposing cast was available, it was possible to articulate the casts in 89% of cases (n = 93). Of the 11 cases that could not be articulated, three were being provided on a private basis, seven were being provided with NHS funding and one was received by the Dental Hospital ‘in-house’ laboratory. The technician proceeded with crown fabrication in six of the 11 cases where articulation of the casts was not possible, of which two were provided on a private basis and four were provided with NHS funding.

When asked to describe the quality of the written instructions received, it was reported that:

- 49% (n = 52) instructions were clear and adequately described the planned crown;
- 35% (n = 38) were a guide and some of the design was left to the technician’s discretion;
- 6% (n = 6) were poor and left most of the responsibility for the design to the technician;
- 9% (n = 10) had no written instructions;
- 1% (n = 1) had illegible instructions.

Table 1 shows the distribution of these descriptions according to the funding scheme. In 21% of cases (n = 22), the technician had to contact the dentist for clarification of the design prior to making the crown. A variety of reasons were given for this including checking the shade, material, tooth characteristics or margin type required, or to clarify the instructions in other ways.

Within the written instructions, the prepared tooth was identified in the written instructions in 94% of cases (n = 101). The material required for crown fabrication was specified in 92% of cases (n = 99).

Regarding the aesthetic appearance of the prescribed porcelain-fused-to-metal and all-ceramic crowns (n = 98), a single porcelain shade was prescribed in 56% of cases (n = 55), multiple porcelain shades were prescribed in 36% of cases (n = 35), while no shade was prescribed in 8% of cases (n = 8). Details of prescription of shade patterns are reported in Table 2.

For porcelain-fused-to-metal crowns (n = 63), the design of the occlusal/palatal surfaces (e.g. metal-only or metal covered by ceramic) were prescribed by the dentist in 16% of cases (n = 10).

**Discussion**

The findings of this study illustrate some of the practices employed by Welsh general dental practitioners and dental technicians in the production of single-unit crowns, and are also quite indicative of the relationship that exists between these two members of the dental team.

In this study, less than one-half of written instructions (n = 52) were considered ‘clear’ and of sufficient detail to adequately specify the planned crown. It is important that dental practitioners recognize their ethical and legal responsibilities in this regard. While the dental technician is an important and valuable member of the oral healthcare delivery team, they are not trained to diagnose or manage oral diseases, such as caries or periodontal disease (6). In this study, a decision on features of the design of the planned crown was delegated to the dental technician in more than

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**Table 1.** Quality of written instructions described according to the funding arrangements under which the work was provided

<table>
<thead>
<tr>
<th></th>
<th>Private, n (%)</th>
<th>NHS, n (%)</th>
<th>Dental Hospital, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>29 (45)</td>
<td>15 (47)</td>
<td>8 (73)</td>
</tr>
<tr>
<td>A guide</td>
<td>28 (44)</td>
<td>7 (22)</td>
<td>3 (27)</td>
</tr>
<tr>
<td>Poor</td>
<td>3 (5)</td>
<td>3 (9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>None</td>
<td>3 (5)</td>
<td>7 (22)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Illegible</td>
<td>1 (2)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Total</td>
<td>64 (100)</td>
<td>32 (100)</td>
<td>11 (100)</td>
</tr>
</tbody>
</table>

NHS, National Health Services.
One-half of written instructions. For example, in relation to porcelain-fused-to-metal crowns ($n = 63$), the design of the occlusal/palatal surfaces was not prescribed by the dentist in 84% of cases ($n = 97$). This is clearly inappropriate and exposes the patient to risk. It has been demonstrated that the inappropriate placement of porcelain on occlusal surfaces of crowns which oppose natural teeth can lead to accelerated attritional tooth surface loss on opposing teeth (26). It is clearly inappropriate for the prescribing clinician not to collect the relevant clinical information and make a decision on the appropriateness of the design of this feature of the crown. It should not be left to the discretion of the dental technician, who does not have access to clinical information regarding the patient, let alone the necessary training in respect of relevant clinical entities such as tooth wear, attrition or bruxism. Notwithstanding this, the standard of communication for single-unit crowns in Wales is comparable, if not slightly better than observed in other studies (14, 18, 25), or for other prostheses such as cobalt–chromium removable partial dentures (5, 11, 12, 24).

The phenomenon of poor quality prescription of prosthodontic work is not limited to single-unit crowns, and has been demonstrated in association with other prosthesis types, such as removable partial dentures (5, 11, 12, 24) and fixed bridges (14, 18). The reason for this underperformance of dental practitioners has been traditionally ascribed to either educational or financial issues (5, 24). However, the role of financial considerations seems less likely, given previous work that compared the quality of prescriptions completed under a range of financial remunerative schemes and found that the quality (or lack of quality) was comparable across a range of remunerative schemes (27). Furthermore, the prescriptions examined in this study were completed under the ‘new’ remunerative arrangements, i.e. the new NHS contract, and there seems to have been little change in comparison with studies carried out under previous financial arrangements (18, 25, 28). Also, a study on the quality of written instructions performed in Ireland, where work was provided completely on a private basis (hence as the practitioner was allowed set their own fee, and was therefore able to ‘charge’ for their time in prescribing the prosthesis), found that the quality of written instructions was still poor (14). Previous work in the field of endodontics has indicated that increasing fees alone for treatment will not necessarily improve the quality of treatment provided (29). It is likely that the reasons for this poor phenomenon of inadequate prescription is related to educational issues – possibly a lack of educational exposure to this subject at the level of undergraduate, postgraduate, or a continuing professional development/continuing educational stages. This may also be a manifestation of poor confidence on behalf of the prescribing practitioner, or maybe, at worst, a reflection of an attitudinal problem within the profession? This has been previously highlighted in other studies where best clinical practice has been ignored, such as in the use of rubber dam for endodontic treatments (30). There is much scope for further investigation of this concept.

The quality of master impressions and related materials observed in this study were, on the whole, satisfactory. All impressions were made using polyvinylsiloxane, while there was a strong reliance on the use of plastic stock trays (almost 80%). While the use of a plastic stock tray is appropriate for making a master impression for a crown, it is important that the selected tray is of sufficient rigidity to resist distortion/deforation when a highly viscous impression material such as heavy-bodied polyvinylsiloxane is selected (28, 31). It is perhaps noteworthy that within this study, all 16 master casts considered to be unsuitable for crown fabrication were made from impressions recorded using a plastic stock tray.

Another concern did arise in this study when it was noted that one impression had not been disinfected adequately before being sent to the laboratory, and visibly had blood attached to it. It is worth remembering that communication of such infected materials to the laboratory exposes members of the dental team to risk of infection to possible diseases such as HIV and hepatitis C (32). Notwithstanding this, previous studies by the authors have found that sizeable numbers of master impressions received by the dental laboratories were not disinfected [contaminants were visible on as many as 11% (14), and 15% (18), of master impressions, respectively, in two separate studies]. However, both of these studies had much larger sample sizes and wider distribution.

Fifteen per cent of master casts ($n = 16$) were not of an acceptable standard to enable production of a crown. When comparing between cases produced under different financial arrangements, cases made in the Cardiff Dental Hospital were found to have the highest
proportion (28%, \( n = 8 \)) of unacceptable master casts. Twenty-five per cent of master casts (\( n = 8 \)) derived from general practice/NHS funding were thought to be of insufficient accuracy, while only 8% (\( n = 5 \)) of privately funded cases in general practice were inadequate. These bear comparison with a recent study of impressions for fixed prostheses in 249 patients, which found only 3.14% of impressions were clinically unacceptable (33). Impressions from the Cardiff Dental Hospital were made by undergraduate dental students and despite the fact this work is supervised by qualified clinical teachers, it is somewhat surprising that such a large proportion of casts were unsuitable. Possible explanations for the high proportion of rejections from student work in this study could relate to the small sample size (\( n = 11 \)), and that being a dental educational institution, stricter assessment criteria are used.

It is of concern that three cases examined in this study had no opposing cast available, while it was not possible to articulate the master cast with the supplied opposing cast in a further 11 cases. However, in all of the former, and in six of the latter, the technician still fabricated the crown suggesting these were fabricated without any consideration of the occlusion of the patient. The hazards of such an approach include placement of a crown with an insufficient occlusal contact, allowing supra-eruption of the opposing tooth or complaints from the patient of decreased masticatory efficiency, or the need for excessive occlusal adjustments at the cementation appointment, with loss of chairside time and patient confidence, or the incorporation of an occlusal error into the completed crown with associated risks of bruxism or temporomandibular dysfunction.

There are a number of limitations to this study, which should be considered when interpreting the results, particularly the use of a small number of commercial laboratories, and the relatively small sample size. However, each of these laboratories had large catchment areas within Wales, and reportedly, each impression was from a different dental practitioner. A number of technicians assessed the cases in each laboratory, thereby reducing the possibility for bias as much as possible. This methodology is in keeping with other similar studies that have been previously published (11, 13, 14, 18, 23). The sample size from the Dental Hospital was much lower than that from commercial laboratories, but being in excess of 50% would still be regarded as an acceptable response rate for questionnaire-based studies (30, 34). The overall response rate is comparable with previously published investigations in this area (14, 23). Notwithstanding this, if this study is repeated in the future, an increased sample size should be considered.

Conclusion

Within the limitations of this study, it has been found that:

- the majority of impressions made for single-unit crowns were adequate, and ‘fit for the purpose’;
- however, more than one-half of written instructions examined failed to meet the standards expected by the European Union Medical Devices Directive.

References


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