A clinical evaluation of fixed partial denture impressions

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Statement of problem. Providing the dental laboratory with an accurate replication of the hard and soft tissue of a patient is important. Therefore, it is essential to examine whether clinicians critically evaluate impressions routinely before sending them to the laboratory.

Purpose. This study evaluated the quality of impressions sent to commercial laboratories for the fabrication of fixed partial dentures (FPD) by describing the frequency of clinically detectable errors and by analyzing correlations between the various factors involved.

Material and methods. A total of 193 FPD impressions were evaluated, immediately after arrival at 11 dental laboratories, by 3 calibrated examiners. The impression technique and material used, tray type, and number of prepared units were recorded for each impression. Data relating to errors and faults, including defects in material polymerization, retention to tray, tissue contact by tray, crucial areas beyond tray borders, heavy-bodied material exposure through the wash material (for double-step impressions), inadequate union of materials, retraction cords embedded in impressions, and air bubbles, voids, or tears along the margin were also documented. The data were analyzed with the Pearson chi-square test (α=.05).

Results. Of the impressions, 89.1% had 1 or more observable errors. Significant correlations were found between material type and voids or tears at the finish line (Rv = 0.17, $P<.025$) and between material type and polymerization problems (Rv = 0.223, $P<.004$).

Conclusions. Within the limitations of this study, impressions made with polyethers had the most detectable errors, followed by condensation-type silicones. The high frequency of detectable errors found in impressions sent for FPD fabrication is of concern. (J Prosthet Dent 2005;94:112-7.)

CLINICAL IMPLICATIONS

Based on the results of this study, more critical evaluation of impressions for fixed prosthodontics on the part of the dentist is recommended.

Transfer of an accurate replication of the patient's hard and soft tissue to the dental laboratory is important.[1] Most dentists have experienced the results of making a poor impression. The ability to identify and analyze inaccurate impressions and to understand how to avoid them is key to successful restoration. There are various techniques for making fixed partial denture (FPD) impressions.[2-7] These include the following: (1) the single copper band technique, (2) the monophase technique (in which an impression material of only 1 viscosity is used), (3) the single-step technique (in which impression materials of 2 viscosities are applied at the same time), or (4) the double-step technique (in which the impression is made in 2 steps, using material of different viscosity in each step).

Since impressions replicate both the teeth and the gingiva, success is based on understanding the anatomy of the periodontal tissues, creating an accurate and decipherable preparation (especially at the finish line), using the correct impression material and appropriate techniques.[1,3,8] However, none of these alone will ensure an accurate impression. Many studies on impression accuracy have been published.[9-14] The majority were in vitro studies in which it was assumed that the evaluated impressions were acceptable, meaning no visible errors were observed. Only a few studies reported on the quality of the impressions made in vivo.[15,16] Therefore, it is important to examine whether clinicians critically evaluate impressions routinely before sending them to the laboratory. The aim of this study was to evaluate the quality of impressions sent to commercial laboratories for fabrication of FPDs, to describe the

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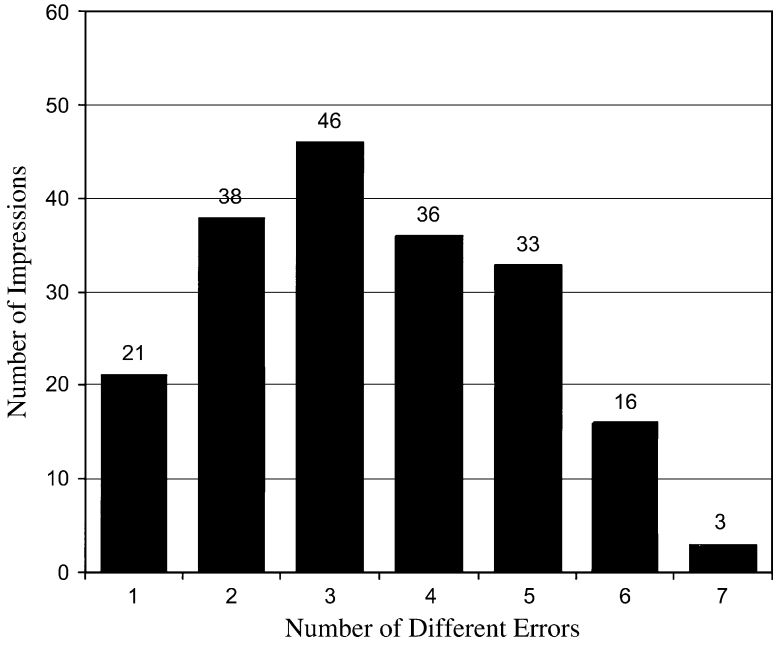

Fig. 1. Frequency distribution by number of errors; 172 impressions had 1 or more detectable errors.

frequency of clinically detectable impression errors, and to determine possible correlations between various factors.

MATERIAL AND METHODS

A total of 193 FPD impressions from 11 commercial dental laboratories were examined between May and July 2002. Forty-one dentists submitted the impressions with a request for FPD fabrication. Impressions without specific requests for FPDs, or those made with materials with which the examiners were not familiar, were excluded from the study.

All impressions were evaluated immediately after reaching the laboratory. The impressions were numbered prior to evaluation so that the identities of the dentists were unknown to the examiners, preventing bias. Other than numbering them, the impressions were not manipulated by the laboratory staff prior to examination. The impressions were evaluated by 1 of 3 calibrated examiners. Interoperator calibration was achieved by having the examiners inspect 10 impressions to determine common standards before analyzing the specimens. Statistical analysis of the calibration was not performed, since the evaluation results according to the criteria mentioned below were identical for all 3 examiners for all 10 impressions.

For each impression, the jaw, technique, tray type, material, and number of prepared units were recorded. Data referring to errors and visible defects were also documented, including defects in material flow, inadequate retention to the tray, tissue contact by the tray, crucial areas outside the tray border, heavy-bodied material exposure through the wash material for double-step impressions, inadequate union of the materials, retraction cords embedded in the impressions, and air bubbles, voids, or tears along the finish line.

Table I. Occurrence of various detectable errors

Criteria	Percent occurrence*
Voids or tears at finish line	50.7 (98)
Putty exposure through wash (in double-step technique)	44.0 (85)
Air bubbles at finish line	40.4 (78)
Pressure of tray on soft tissue	38.3 (74)
Inadequate retention of material to tray	33.7 (65)
Flow problems	23.8 (46)
Retraction cord attached to impression	6.2 (12)

Of 193 impressions for FPD evaluated by 3 examiners, 172 (89.1%) had 1 or more detectable errors.
*Percentages relate to 193 impressions. Total number in parentheses.

The collected data were examined for the frequency of occurrence of each observation, and the correlations between observations were computed using Cramer V correlation statistics. Statistical software (SPSS version 10.1; SPSS Inc, Chicago, Ill) was used for statistical analysis. The Pearson chi-square test was used to determine significance (α=.05).

RESULTS

Of the 193 impressions examined, 99 (51.3%) were maxillary impressions and 94 (48.7%) were mandibular impressions. Of the impressions, 49 (25.4%) contained 4 or more FPD abutments; 69 (35.8%) contained 2 or

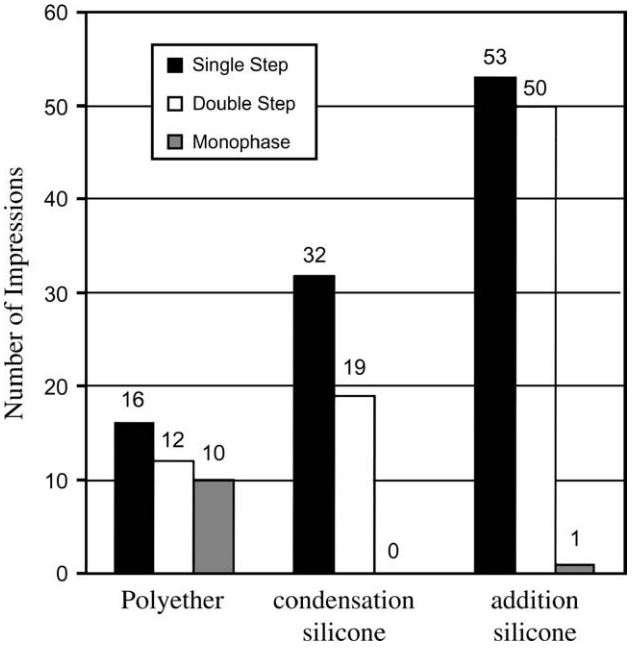

Fig. 2. Distribution of impression materials by impression technique. Significant correlation was found between impression material and impression technique ($P<.0001$).

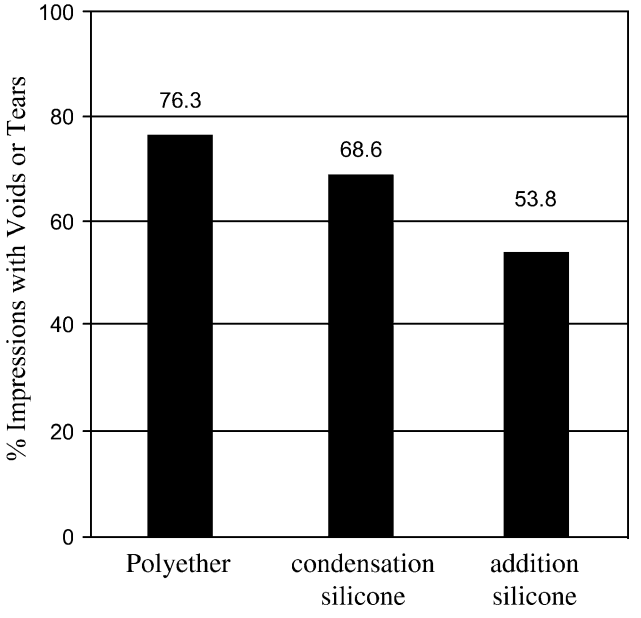

Fig. 3. Distribution of voids or tears at finish line area by type of impression material. Significant correlation was found between presence of voids or tears at finish line area and impression material used ($P<.025$).

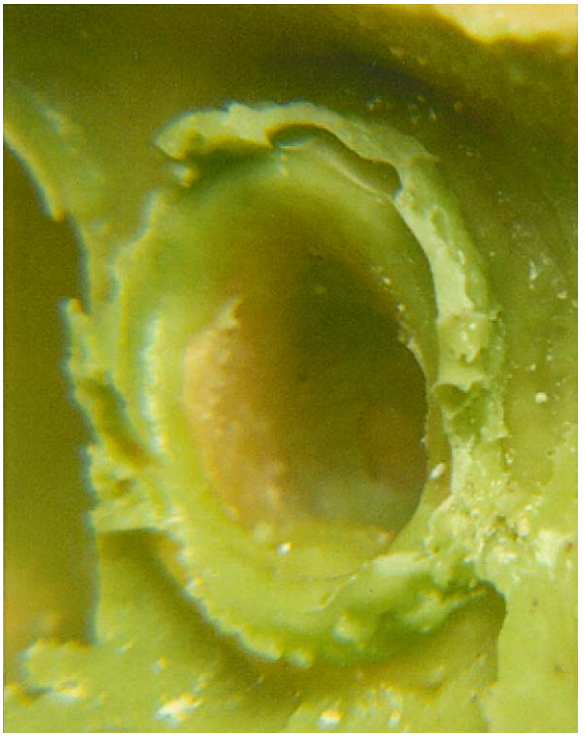

Fig. 4. Representative impression demonstrating voids and tears at finish line.

Fig. 5. Representative example of air bubbles at finish line. Of 193 impressions, 77 (40%) had air bubbles at margin line.

3 abutments, and 75 (38.8%) included a single unit. The monophase technique was used in 11 (5.7%) of the impressions, the double-step technique in 81 (42%) of the impressions, and the single-step technique in 101 (52.3%) of the impressions. The distribution of impression materials was 38 (19.7%) polyether; 51 (26.4%) condensation-type silicone; and 104 (53.9%) addition-type silicones. Custom trays were used for 1 (0.5%), rigid

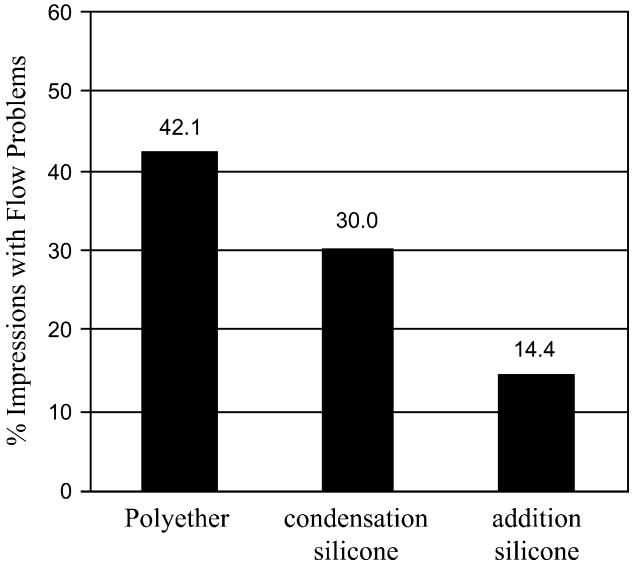

Fig. 6. Distribution of flow problems by impression material. Significant correlation was found between flow problems and impression material used ($P<.004$).

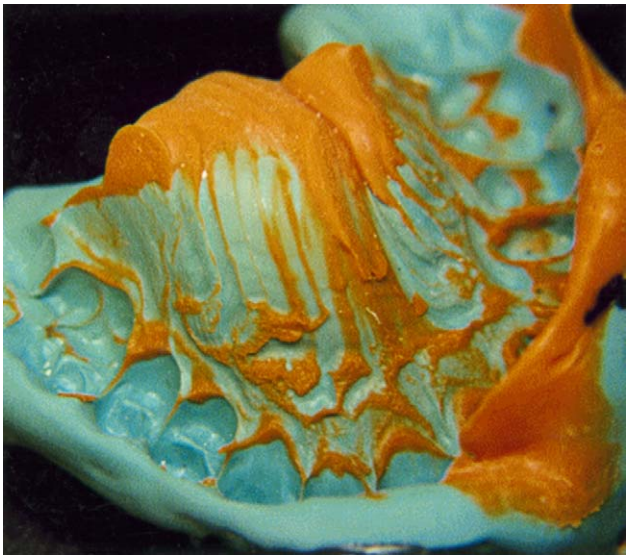

Fig. 7. Flow problems in impression sent for FPD fabrication. Such problems were significantly correlated with impression material used.

plastic trays for 23 (11.9%), metal trays for 63 (32.7%), and soft plastic trays for 106 (54.9%) of the impressions.

Of the 193 impressions, 172 (89.1%) had 1 or more detectable errors. Thirty-eight (19.7%) impressions had 1 error, 46 (23.8%) had 2 errors, 36 (18.7%) had 3 errors, 33 (17.1%) had 4 errors, 16 (8.3%) had 5 errors, and 3 (1.6%) had 6 different detectable errors. A description of these errors and their frequencies appear in Table I. The frequency distribution according to number of errors is shown in Figure 1.

A significant correlation was found between impression material and impression technique (Rv = 0.319, $P<.0001$). Of the addition-type silicone impressions, 51% were made using a single-step technique, 48% using a double-step technique, and 1% using a monophase technique. Of the condensation-type silicone impressions, 62.7% were made using a single-step technique and 37.3%, using a double-step technique. Of the polyether impressions, 26.3% were made as monophase impressions, 42% were made using a single-step technique, and 31.7% were made using a double-step technique (Fig. 2). A significant correlation was found between the type of material used and voids or tears at the margin line (Rv = 0.17, $P<.025$), as 76.3% of the polyether impressions, 68.6% of the condensation-type silicones, and 53.8% of the addition-type silicones demonstrated this error (Fig. 3). Examples of voids and tears and air bubbles at the finish line area are shown in Figures 4 and 5, respectively. Significant correlation was also found between the type of material used and problems indicating a lack of flow of the material. (Rv = 0.223, $P<.004$) Flow problems were observed in 42.1% of the polyether impressions, 30% of the condensation-type silicones, and 14.4% of the addition-type silicones (Fig. 6). An example of a flow problem is shown in Figure 7. No other significant correlations were found.

DISCUSSION

Dentists face numerous clinical challenges, and evaluating self-performance for quality assurance can be demanding. In this study, impressions were examined according to the following criteria: the use of appropriate trays, sufficient retention of the impression material to the tray, complete polymerization of the materials with proper adherence to each other, and the absence of bubbles, voids, or tears along the finish line.

This study showed that 89.1% of the impressions had 1 or more detectable errors. These findings are in agreement with Winstanley et al[15] and Carrotte et al,[16] although the criteria used for evaluation were not the same. Winstanley and Carrotte assessed retention of the impression to the tray, the accuracy of the impression at the finish line, and the presence of other defects that could affect occlusal relationships. Based on these criteria, the impressions were categorized into 4 groups, ranging from satisfactory to unsatisfactory prosthetic results. According to the present study findings, 50.7% of all the impressions had voids or tears in the finish line area, 40.4% had air bubbles at the margin line, and 26.9% had both.

These errors may be due to difficulties in obtaining an intimate contact between the impression material and the tooth in an area in which biological fluids and air are present, faulty manipulation of the impression

material while placing it around the prepared tooth, or premature removal of the impressions from the mouth. The fact that impressions are often removed from the mouth when the dentist ''feels'' that the material has polymerized, disregarding the polymerization time recommended by the manufacturer, may explain premature removal.

Significant correlations were found only between material type and voids and tears at the finish line, and between material type and flow problems, which suggests that that polyethers, followed by condensation-type silicones, are the most improperly used materials. This may be explained by partial compliance with the manufacturer's instructions, such as uneven hand mixing. The use of electromechanical mixers may minimize this problem. Another explanation for this finding might be the use of stock trays rather than custom trays for polyether impressions. Insertion of a large amount of monophase material into a stock tray could result in layering patterns and trapped air. It is difficult to account for the discrepancy between the prevalence of monophase impressions (5.7%) and the use of custom trays (0.5%). The results of this study indicate that the most commonly used materials were addition-type silicones (49.8%) followed by condensation-type silicones (24.4%). The least commonly used materials were polyethers (18.2%). Although addition-type silicones are more expensive than condensation-type silicones, they allow for a longer time between making the impression and pouring it.[8] Also, cartridge dispensers for addition-type silicones avoid the need for hand mixing. The limited use of polyethers by dentists could be attributed to their high cost and strong taste,[8] or to the fact that dentists are less familiar with this type of material.

Another finding emerging from the present study is that single-step impressions are the most frequently used. This method is faster and probably adopted by experienced dentists to decrease procedure time, but it does not allow for the error compensation inherent in the double-step technique. A significant correlation between technique type and defects at the finish line was not found. The relative accuracy of these 2 impression techniques has been previously discussed[6,7] and is beyond the scope of the present article.

The most widely used impression trays were soft plastic stock trays (54.9%), as found in previous studies.[15,16] The use of a soft plastic stock tray cannot be considered a ''visible defect,'' although there is possibility for inaccuracies due to the flexible nature of these trays.[14,15] The widespread use of such trays may be related to their low price and/or to the clinician's lack of knowledge regarding their shortcomings. Regardless of tray type, 33% of all impressions showed inadequate retention to the tray, an error that can be readily avoided by using the proper removal technique or appropriate adhesive. It is difficult to determine whether lack of knowledge or lack of attention resulted in these impressions being sent to the laboratory.

These findings are based on criteria for producing satisfactory impressions. The high incidence of imperfect impressions is disturbing. The possible underlying causes include low awareness of the need for critical self-evaluation, clinical or financial pressure, and lack of knowledge or ethics.

This study is based on the review of impressions made by 41 dentists and sent to 11 commercial dental laboratories. The laboratories included in this study were not randomly selected but were chosen according to geographic availability and access by the examiners. Dentists' identities were not recorded due to ethical issues, although this information could be valuable. A limitation of the study is the lack of magnification equipment used during examination. Magnification might have made the proportions of faulty impressions even higher.

This study examined only the outcome of impression making, but further studies are needed to evaluate the quality of the dies and the outcome of the definitive restoration. It is possible that the technician will, upon reviewing the final cast and detecting possible problems, send it back to the dentist for further instructions. Therefore, it is impossible to determine, according to this study, the proportion of faulty impressions that actually became definitive restorations and whether these restorations would be deemed acceptable.

CONCLUSIONS

Within the limitations of this study, impressions made with polyethers followed by condensation-type silicones have the most detectable errors. The high frequency of detectable errors found in impressions sent for FPD fabrication is a concern. A more critical evaluation of impressions on the part of the dentist is recommended.

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