Eur. J. Prosthodont. Rest. Dent., Vol.22, No. 1, pp 11-18
Printed in Great Britain

doi:10.1922/EJPRD_1259Storey08

The Quality of Impressions for Crowns and Bridges: An Assessment of the Work Received at Three Commercial Dental Laboratories. Assessing Qualities of Impressions that May Lead to Occlusal Discrepancies with Indirect Restorations.

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Abstract - *There are few published studies that directly assess the quality of impressions for crowns and bridges in the UK. This paper considers aspects of impression quality with particular attention to factors causing potential occlusal discrepancies in the final restoration. To this end three dental laboratories were visited over a 3-month period. All impressions for conventional crown and bridgework that arrived on the days of the visits were examined and assessed against criteria defined on a custom-designed assessment form. A total of 206 impression cases were considered in this study. Flexible impression trays were used for 65% of working impressions. Their use was more common for NHS work than for private work. 31.9% of all alginate impressions examined were not adequately fixed to the tray. Visible contamination of impressions was not uncommon.*

KEY WORDS: Impression, quality, crown, bridge

INTRODUCTION

The previously published part of this study[1] considered the qualities of dental impressions for fixed crown and bridgework as they relate to the recording of the prepared teeth. Whilst these qualities are of the utmost importance to the satisfactory production of a finished restoration, they are not the only factors that need to be considered when carrying out these indirect, laboratory based procedures. This paper considers factors that may lead to occlusal discrepancies and will also consider the issue of cross-infection control.

MATERIALS AND METHODS

Three commercial dental laboratories were visited over a four month period between January and April 2010. These laboratories were chosen due to their geographical convenience to the author, and the fact that they receive the full range of fixed restorative work. All impressions which were received by the dental laboratories taking part in the study that requested conventional crown and bridge work were examined on the days on which the author visited the laboratories, and impressions involving multiple preparations would be counted as one case. All of the three laboratories chosen to take part in this study receive the full range of fixed restorative work.

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Protocol for Inspecting Impressions

To evaluate the impressions an assessment form was developed to give a structured assessment protocol. The previous published study[1] considered impressions of the prepared teeth and impression techniques. For the purposes of this paper, the protocol form was used to assess issues such as the choice of impression tray, factors that may affect occlusal accuracy, the presence of blood or debris on the impressions and for evidence of disinfection (although in practice this proved difficult to assess). Each impression was also examined to see if it was firmly fixed to the impression tray. Both the working and opposing arch impressions were examined during this assessment.

RESULTS

Summary of Work Inspected

The total number of impressions examined was 206. However, 4 cases did not specify whether they were to be done under NHS or private contract. These cases are a valid contribution to the assessment of the quality of impressions produced by general dental practitioners. They have therefore been included in the overall assessment of impression quality but excluded when assessing NHS or private work specifically. Of those that did state contract details, 113 specified NHS and 89 specified private (54.9% and 43.2% respectively of the total 206 cases).

To help simplify interpretation of the results the data gathered from each laboratory has been gathered together and grouped under Private, NHS or All Contracts. A summary of this information is presented in Table 1.

Table 1. Number of NHS and private impression cases examined.

	NHS n (%)	*Private n (%)*	*Total NHS+Private n (%)*
Number of Cases (Percentage)	113 (54.9%)	89 (43.2%)	206 (100) *

(* The 4 cases that did not specify whether the work was to be done under NHS or private contract are included in this total)

Figure 1. *An example of a sectional impression in metal trays.*
The prescription requested the construction of a non-precious full metal crown for 47 (the last tooth in the arch). This case was judged unsatisfactory due to both lack of marginal definition and potential occlusal problems.

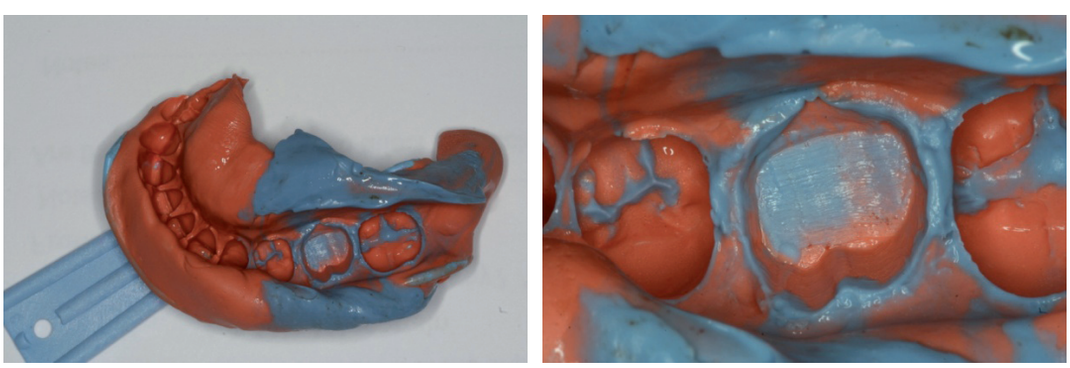

Figure 2. *A typical example of an impression made in a cut down solo tray.*
The reason for cutting down the tray remains unclear. Discussion with the technician revealed some practitioners use cut down trays routinely. This impression was judged to be unsatisfactory with regard to clarity of margins and will probably have proven inaccurate when trying to establish stable occlusal contacts between opposing casts.

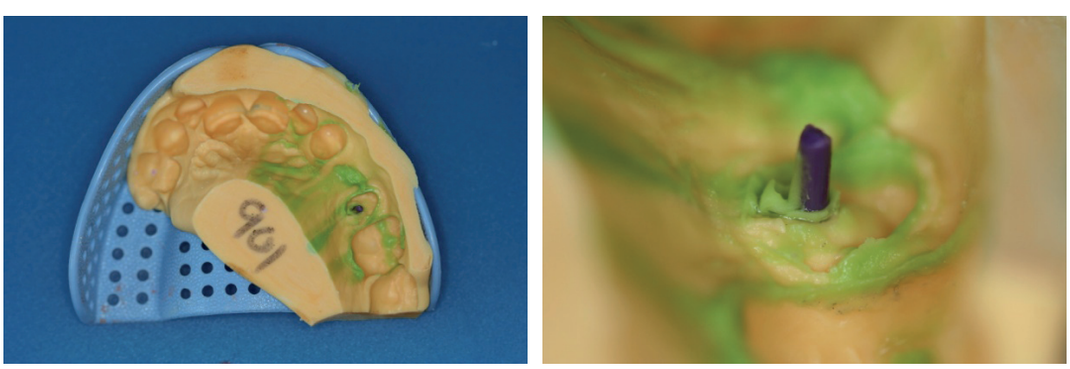

Figure 3. *Partially filled impression tray.*
This photograph shows a full arch tray only partially filled with silicone impression material. It was inspected prior to being modified by the technician but only photographed just before casting. The impression is clearly inadequate with regard to its reproduction of the prepared tooth (this study is not focussed on the quality of the preparation). Once again, there are potential problems with relating the subsequent casts to each other so that a restoration with a reliable functional occlusion can be made.

The Working Impression

Type of Impression Tray Used

Of the 206 impressions examined, 134(65%) were made using flexible plastic disposable trays (typically the plastic Solo tray manufactured by J & S Davis, which were used in 125 cases). Seventeen (8.3%) were made in plastic disposable trays of a more rigid design. Twenty six (12.6%) were made using metal stock trays, all but one of which were done under private contract. Seventeen (8.3%) were dual-arch impressions using trays and 2 (1%) were dual-arch impressions where no tray was used at all. 8 sectional impressions were taken, 2 in metal trays and 6 in plastic Solo trays that had been sectioned. 5 impressions were taken in full arch trays which were only partially filled with impression material (see Figures 1, 2 and 3 for examples). Two impressions were made using a custom tray under private contract.

The breakdown of the different tray types used for NHS and private work is detailed in Table 2 (the 4 cases in which the type of contract was not specified have been excluded from this table).

Plastic Solo trays were used in making the working impression in 73.5% (n=83) of NHS cases and only 45.2% (n=38) of private cases.

Table 2. Type of impression tray used for working impressions (NHS/Private)

Tray Type	*Contract Type*	
	NHS ***n*** (%)	*Private* ***n*** (%)
Custom	0 (0%)	**2** (2.2%)
Metal Stock	**1** (0.9%)	**25** (28.1%)
Rigid Plastic Disposable	**4** (3.5%)	**13** (14.6%)
Flexible Plastic Disposable	**87** (77%)	**43** (48.3%)
Sectional Tray	**7** (6.2%)	**1** (1.1%)
Dual-Arch With Tray	**12** (10.6%)	**5** (5.6%)
Dual-Arch Without Tray	**2** (1.7%)	0 (0%)
Total	**113** (100%)	**89** (100%)

Table 3. Provision of opposing arch impressions/models.

	*All Cases**	*Private Contract*	*NHS Contract*
Working Arch Impressions	187	84	99
Opposing Arch Impression Taken	161	70	87
No Opposing Arch Impression Taken	16	5	11
Opposing Arch model provided	10	9	1

(* This column includes the 4 cases that did not specify contract type)

The Opposing Arch Impression

A total of 161 opposing arch impressions were taken, not including the 19 dual-arch impressions. In some cases opposing models or study models were provided instead of an impression. A summary of this information is provided in Table 3.

The breakdown of the different tray types used for the opposing impression for NHS and private work is detailed in Table 4 (the 4 cases in which the type of contract was not specified have been excluded from this table, as have the 19 dual-arch impressions that were assessed for this study). The total number of opposing arch impressions examined requesting private work was 70. There were 87 opposing arch impressions accompanying NHS prescriptions.

Of the 87 impressions assessed that requested NHS work, 78 (89.7%) were made using flexible plastic Solo trays. By comparison, 57.1% (n=40) of impressions taken under private contract used Solo trays and 10 (14.3%) were taken in metal stock trays.

Alginate was the most common impression material. It was used for 86 of the 87 impressions made under NHS contract and 56 of the 70 impressions made under private contract. Silicone was used as the impression material once under NHS contract and 14 times under private contract.

Table 4. Type of impression tray used for opposing arch impressions (NHS/Private).

Tray Type	*Contract Type*	
	NHS *n*	*Private* *n*
Metal Stock	0	10
Rigid Plastic Disposable	4	12
Flexible Plastic Disposable	82	48
Sectional Tray	1	0
Total	87	70

Defects Related to Occlusion

Dual-Arch Impressions

Dual-arch techniques were used in 19 of the 206 cases assessed. They were used more frequently for NHS work (n=14, 12.4% of NHS cases) than for private work (n=5, 5.6% of private cases). 17 of these impressions used trays while 2 impressions requesting NHS restorations did not. Of these impressions only 5 (including both the impressions taken without a tray) had defects in the recording of the prepared teeth that made them unusable. However, 10 had occlusal problems that would complicate the fabrication and/or fitting of the restoration. Of these, 2 impressions were recorded with the teeth not in intercuspal position, 2 had the impression tray interposed between the opposing dental arches and 6 were assessed as having insufficient teeth to produce stable occlusal contacts. Examples are given in Figures 4, 5 and 6.

Full and Partial Arch Working Impressions

Of the 187 such impressions examined 20 exhibited faults that could affect the occlusion. Step defects were a common finding where a two-stage putty-wash technique was employed. They occurred where insufficient silicone wash had been used to cover the entire dental arch that was being recorded. In some cases the defect created could potentially be the source of considerable occlusal inaccuracy (Figure 7). Of the 30 two-stage putty-wash impressions examined, 8 had step defects.

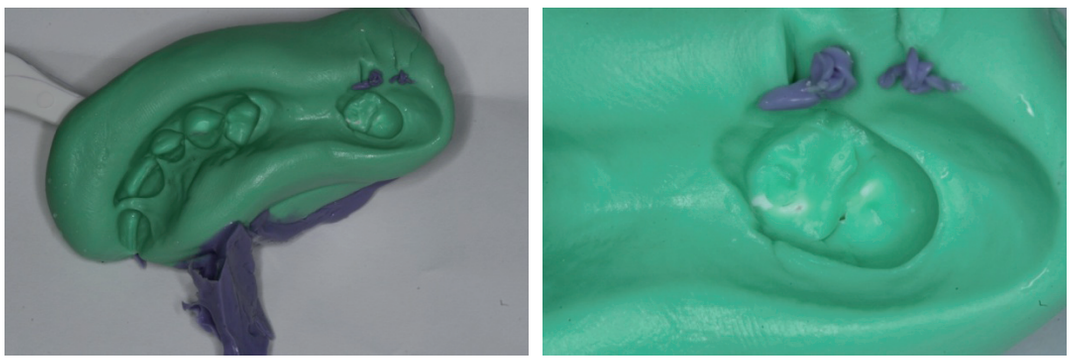

Figure 4.
The white, plastic impression tray can be seen on the close-up image running across the occlusal surface of the molar tooth. An occlusal discrepancy is almost inevitable.

Figure 5.
This impression was sent with a request for a non-precious bonded crown on 47. This tooth was in occlusion. The inability to accurately position opposing casts will be problematic in making a restoration with correct occlusal contacts.

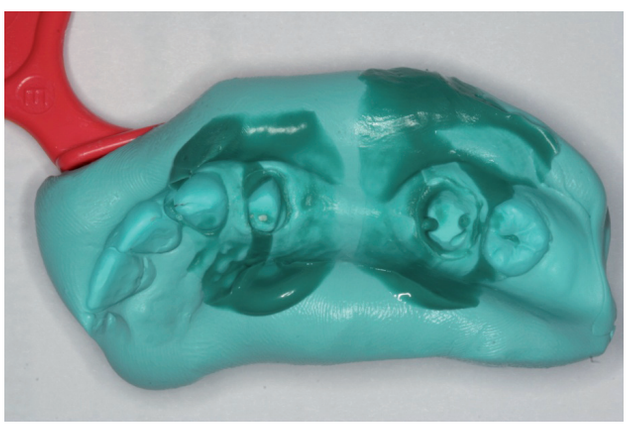

Figure 6.
This impression for a 4-unit bonded bridge demonstrates excellent reproduction of the prepared teeth. However, the remaining occlusal contacts are few and it is unlikely that the casts of the impression can be accurately articulated. Occlusal problems are likely due to an inappropriate use of the dual-arch technique.

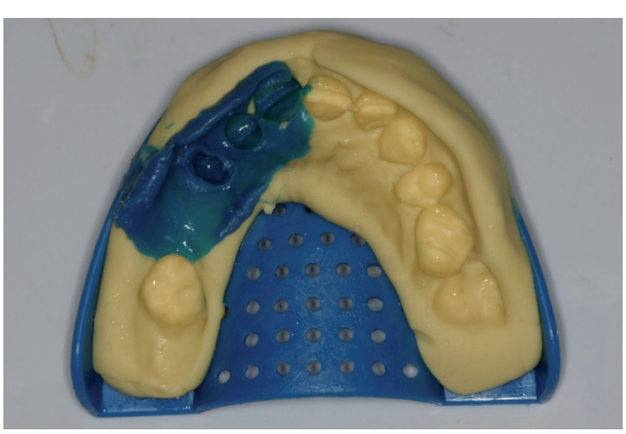

Figure 7. *Occlusal problem with two-stage putty-wash impression technique. In this example, the wash has only been placed over the prepared tooth and immediate neighbouring teeth creating a step at the limit of its flow. The problem is compounded by the fact that there are no escape channels cut in the putty to prevent a build-up of hydrostatic pressure on insertion of the putty impression (second stage) and allow the flow of wash (light bodied silicone) from the occlusal surface.*

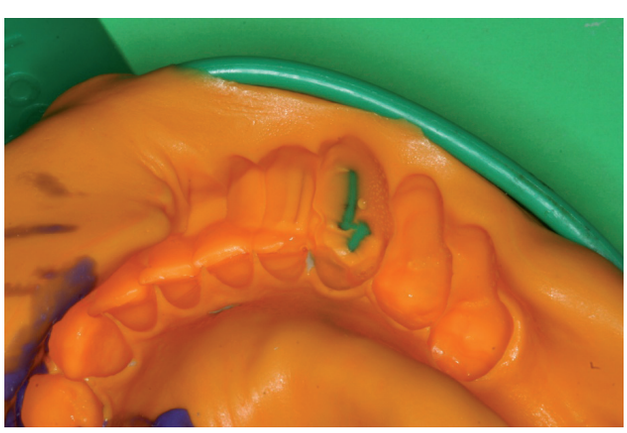

Figure 8. *Occlusal error due to teeth contacting the impression tray. The tray is clearly in contact with the labial surface of the lower canine. The model is likely to need adjustment to achieve a satisfactory occlusion.*

Other occlusal problems encountered with the working impressions were the impression pulling away from the impression tray (n=4), drags on the occlusal surface (n=3), the impression tray used being too small for the dental arch (n=4), and one case where the tray was in contact with the labial surface of the lower anterior teeth (Figure 8).

The Opposing Arch Impression

Defects that could potentially cause occlusal problems were a common finding in this study. Of a total of 161 opposing impressions examined 56 were found to have defects in this regard. None of the 31 opposing impressions made in silicone were seen to be faulty. All of the 56 observed faults pertained to the 144 alginate impressions with the largest source of errors being the alginate impression material pulling away from the tray (Figure 9). 46 of the 56 occlusal faults were due to the alginate being inadequately fixed to the impression tray. This equates to 31.9% of all alginate impressions taken failing in this regard. None of the impressions that pulled away from the tray had evidence that tray fixative had been used.

Other occlusal errors observed included air blows on the occlusal surfaces, use of trays that were too small, and drags on the incisal edges of anterior teeth.

Fixation of Impressions to the Tray

An attempt was made to judge whether a tray adhesive had been used to fix both working and opposing impressions to their respective impression trays. In practice this was a difficult judgement to make. With regard to working impressions no adhesive residue was seen on any of the impressions requesting NHS work and only 6 impressions requesting private work. Examination of the opposing impressions revealed signs of tray adhesive on 7 NHS impressions and 12 private cases. No evidence of tray adhesive being used was ever found on the alginate impressions that pulled away.

Occlusal Records

It is recognised that the taking of an occlusal record is not always necessary provided the working and opposing casts have sufficient stable occlusal contacts remaining to be readily and accurately articulated. Indeed, the introduction of an inter-arch recording medium between unprepared teeth may introduce occlusal inaccuracy where it to be used by the technician due to separation of the casts. A localised record of the prepared tooth/teeth, if required, will often prove more accurate than a full arch record. However, if we exclude dual-arch impressions this study noted that there were 171 working impressions that had either opposing impressions or opposing models. Of these 97 (56.7%) had some form of occlusal registration and all of these were full arch records. The most commonly used registration medium was an elastomeric material (either silicone or polyether) which was used for 73.2% (n=71) of all occlusal registrations. The frequencies of use of different recording materials are shown in Table 5. From looking at the impressions only it was not possible to determine the accuracy of these records were they to be used by a technician. None of the cases examined were accompanied by facebow records.

Evidence of Disinfection

It was difficult to assess whether impressions had gone through a disinfection procedure prior to arriving at the laboratory. Laboratory B has a tick-box system on its

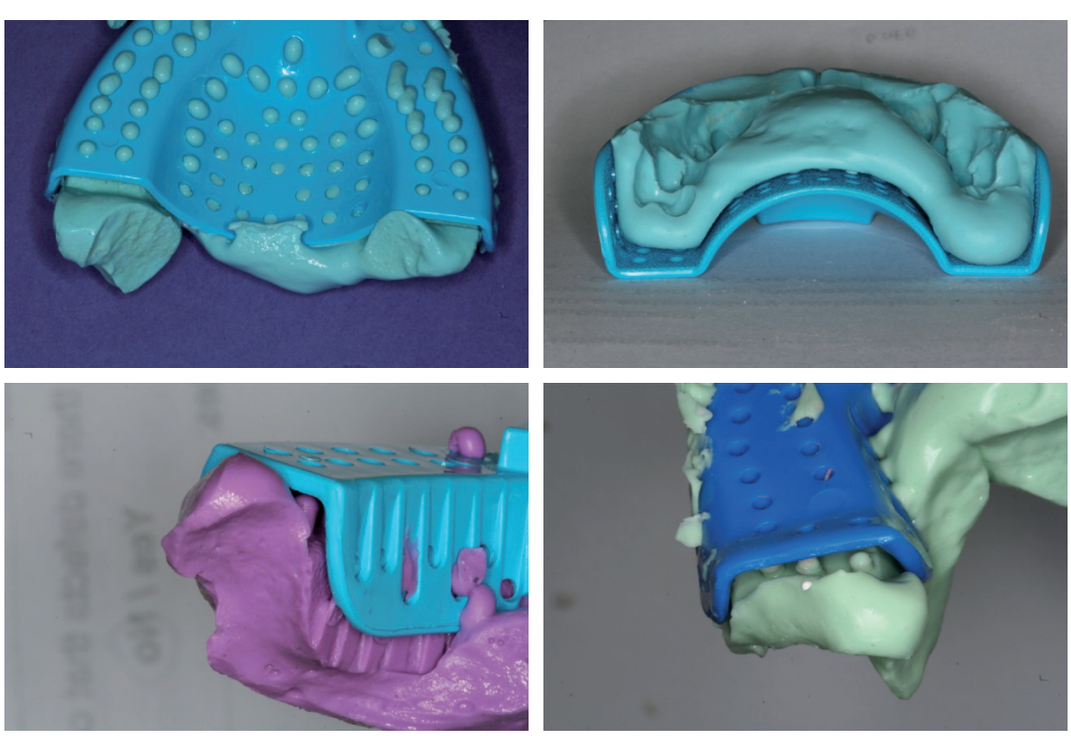

Figure 9. *Impression material pulling away from the impression tray.*

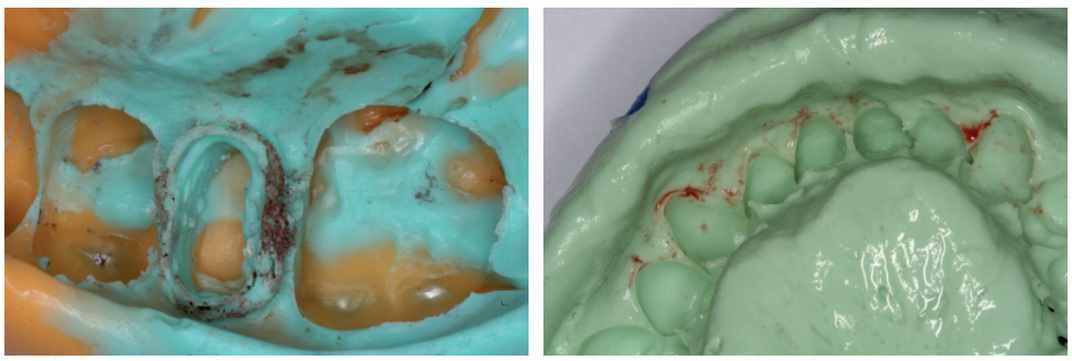

Figure 10. *Contaminated impressions.*

Table 5. Occlusal registration materials used (NHS/Private).

	*All Cases**	*Private Contract*	*NHS Contract*
Wax	21	5	13
Elastomer	71	45	26
Resin	5	5	0
Total	97	55	39

(* This column includes the 4 cases that did not specify contract type)

laboratory prescription to inform the technician whether the impressions have been disinfected. Of the 68 cases examined at this laboratory a total of 63 ticked the box stating the impressions had been disinfected, 2 ticked the box stating the impressions had not been disinfected, and 3 left both boxes blank. However, it was not possible to independently determine or confirm whether such a procedure had been carried out and what agents were used. Of the 206 cases examined 22 used either a sticker or an ink stamp on the prescriptions to state a process of disinfection has been carried out. Overall, 22 (10.7%) of the working impressions and 20 (12.4%) of the opposing arch impressions were contaminated with blood or other debris (e.g. cotton wool rolls, retraction cord, loose amalgam). Figure 10 gives examples of inspected cases.

DISCUSSION

In the previously published part of this study[1] the accuracy of the impressions of the prepared teeth as could be determined clinically were considered. This part of the study has gone on to consider some of the other factors relating to impressions that need consideration if satisfactory indirect crown and bridge restorations are to be made.

Impression Trays

As in previous studies[2-5] the vast majority of impressions were recorded using flexible plastic stock trays which potentially created inaccuracies which were not detectable in this study. Flexible trays may not resist deformation when used with heavy-bodied impression materials and their use may result in an impression that significantly distorts on removal from the mouth. Several studies have demonstrated that rigid trays give greater accuracy than flexible plastic ones, especially when heavy light-body and putty/light-body wash impression techniques are employed[6-9]. Of the 206 working impressions examined in this study, 134 (65%) were made using flexible plastic trays. Of these, 125 used the Solo tray design.

However, if only complete arch impressions are considered, flexible trays account for 94.6% (n=87) of all NHS working impressions and 51.2% (n=43) of working impressions under private contract. The overall trend is of rigid trays being utilised more frequently for private treatment.

Occlusal Problems

The full extent of any occlusal problems was difficult to assess merely by examining the impressions. A better understanding of the presence and magnitude of occlusal errors would have been gained by inspecting and articulating the casts of the working and opposing impressions. However, this was beyond the scope of this study.

Problems were detected with the impressions that would cause occlusal difficulties. By far the most common fault was the inadequate fixation of the opposing alginate impression to the impression tray. Other faults also related to poor impression technique.

Fixation of the Impression to the Tray

In this study 31.9% of all alginate impressions taken were found not to be firmly attached to the tray, thereby making the resulting cast inevitably inaccurate. Once the impression material has distorted it is not possible to push it back into place, and a new impression should have been made. The adhesion of impression material to the tray is dependent on the trays mechanical retentive features (e.g. perforations) and/or the correct use of adhesives[10]. In this study, elastomeric materials separated from the impression trays less frequently than with alginate, occurring only 4 times out of the 228 working or opposing impressions made in silicone or polyether. This is likely to be due to the increased rigidity of the impression material making distortion less likely, or possibly less easy to detect clinically. The combined use of both mechanical retention and adhesives has been shown to produce the most accurate impressions and prostheses[11].

Dual-Arch Impression Techniques

The majority of faults detected from dual-arch techniques related to occlusion. In this study, 10 of the 19 dual-arch impressions had faults in this regard. Used appropriately,

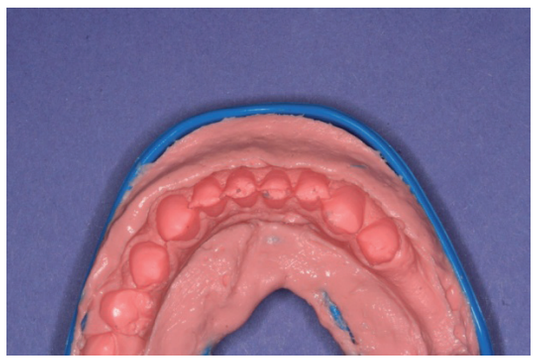

Figure 11.
The impressions were sent in the same bag as a study model.The enclosed alginate had dried out and clearly pulled away from the tray.

dual-arch impressions have been shown to produce results comparable to full-arch impression techniques[12-15]. Dual-arch techniques are suitable for posterior single unit or short span restorations where the abutment(s) are bounded by intact teeth. Ideally, the patient should possess a Class I occlusion with posterior disclusion on excursive mandibular movements[16-18]. Unfortunately, these guidelines were frequently not followed in the impressions examined for this study.

Disinfection of Impressions

Dental impressions can be contaminated with viruses, bacteria and fungi[19,20]. In the UK, the Department of Health published guidance on decontamination in primary care dentistry (HTM 01-05)[21] in which recommendations for the disinfection of dental impressions are given. It recommends the use of labels by the dental practice indicating that a decontamination process had been undertaken. Only 22 (10.7%) of the 206 sets of impressions examined used such labelling.

It was impossible to determine whether a decontamination process had been performed on the impressions prior to arriving at the laboratory, or to know what the process entailed. Worryingly 10.7% of working impressions and 12.4% of opposing arch impressions were visibly contaminated with blood or other debris despite the potential for transmission of infection to the laboratory.

Storage of Impressions

Although not specifically assessed in this study it soon became clear that the means by which impressions were stored for transit to the laboratories was often not ideal. Wide variation in packaging was observed, with some impressions being conveyed almost dry (Figure 11) or completely soaking (Figure 12). Alginate in particular is prone to distortion due to desiccation and water imbibitions[22] so the method of storage for transport to the laboratory is a potential source of avoidable error.

CONCLUSIONS

This study was limited to visually examining the impressions arriving in the dental laboratories before casts were made. It is not possible to say whether the errors noted will have a greater or lesser effect in the satisfactory production of a definitive restoration. It is likely that the errors will have some detrimental effect and, as these errors can be seen with the naked eye, all are avoidable providing the clinician critically evaluates the work being sent to the laboratory. It should also be noted that almost all the work reviewed in this study will have proceeded to have restorations made that will subsequently have been fitted in a patient's mouth.

Figure 12.
There is clearly too much water accompanying this set of impressions.

Taken as a whole, 65% of all single arch working impressions are made using flexible impression trays. However, there is a tendency for impressions made under private contract to be made using more rigid trays.

Dual arch impression techniques are often used inappropriately where insufficient teeth are recorded to provide the technician with adequate information about the occlusion.

Alginate was used for 144 of the 161 opposing arch impressions examined for this study. Of these 31.9% of the alginate impressions examined were not adequately fixed to the impression tray.

Despite the potential cross-infection risks, it is not uncommon for contaminated impressions to be sent to laboratories.

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