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An evaluation of the quality of impressions for orthodontic appliances and study models

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ABSTRACT:
Background: The fabrication of good quality dental appliances and study models depends heavily on the quality of dental impressions undertaken. Accurate impressions are more likely to aid technicians in fabricating appliances that are fit for their intended purpose, avoid remaking of appliances, optimise patient treatment time and reduce laboratory costs; whereas good quality study models are vital for diagnosis and treatment planning, as well as monitoring of treatment progress of patient cases. This study aims to determine the quality of impressions received by anorthodontic laboratory. The objective is to assess whether impressions undertaken were providing sufficient information to the technicians for the construction of the intended lab work.
Methods:A pro forma consisting of 12 essential criteria for good quality impression was formulated. Ninety-nine consecutive alginate impressions (n=99) received by anorthodontic laboratory between 12 August to 7September 2021 were assessed by the dental technicians to determine if the impressions meet the essential criteria. Other essential information such as the type of intended laboratory work requested, completeness of the laboratory prescriptions received and whether the impression require any further adjustments were evaluated.

Results: Data analysis showed that 16.2% of the impressions require further adjustments by the technicians. 47.5% of the laboratory prescription forms had missing information. The criteria that were met by the majority of the impressions were correct position of midline on the impression (92.9%), correct size of stock tray (90.9%) and no grainy impression material (90.9%). 60.7% of the impressions had visible areas of the stock tray within the impression, indicating there was insufficient impression material on certain areas. 37.4% of the impressions had thin impressions on labial surfaces and 25.3% of the impressions had drag marks or tears.
Conclusion: All of the impressions were technically acceptable for the intended laboratorywork although there were areas requiring improvement. Good communication between the clinicians and laboratory technicians is vital for high standard patient care and effective resource management.

I. INTRODUCTION

Ethical and legal guidelines require dental practitioners to adequately design, prescribe and fabricate good quality appliances.[1]The European Union's Medical Devices Directive (Directive 93/42/EEC) stated specific requirements on dental practitioners to provide adequate written instructions when anappliance is being manufactured, and that dental laboratories manufacture the appliance to this specification.[2]As part of the clinical governance framework, dental practitioners are required to keep good health records and that includes accurate study models.[3]

Studies published in the literature have demonstrated that the quality of written instructions and master impressions for both fixed and removable prosthodontics was found to be inadequate.[4-6] A study that examined the selection of impression trays and materials for master impressions for cobalt-chromium based removable partial dentures have found extensive use of inappropriate impression trays and materials.[6] Furthermore, it is suggested that high points on indirect restorations are a result of inaccurate opposing arch impressions from alginate materials.[7]

There is limited information available in the literature on the quality of impressions for orthodontic appliances and study models. Orthodontists depend on support from dental technicians in various stages of treatment.[8] During treatment planning stage, technicians are involved in the fabrication of study models and diagnostic set-ups. During active treatment stage, the fabrication of good quality removable, functional and components of fixed appliances by the technicians is paramount. At the end of treatment, technicians fabricate retainers and study models. In some Oral and Maxillofacial Surgery units in the UK, orthodontic technicians are involved in the fabrication of surgical splints (wafers), whichare fabricated on dental casts

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that have undergone model surgery according to movements prescribed by the clinicians.[8]

This study aims to determine the quality of impressions received by the orthodontic lab in a dental hospital. The objective is to assess whether impressions undertaken were providing sufficient information to the technicians for the construction of the intended lab work. In addition to the Orthodontic Department, the orthodontic labreceives impressions undertaken at various departments such as Paediatric Dentistry, Restorative Dentistry, Oral Medicine and Oral Surgery for fabrications of removable appliances and study models.

Good communication between the clinicians and laboratory technicians is crucial for high standard patient care. The construction of good quality appliances and study models depends heavily on the quality of dental impressions undertaken by clinicians. A defect in the impression will result in a defect on the cast. Accurate impressions willreduce errors and are more likely to aid technicians in fabricating appliances that are fit for their intended purpose, avoid remaking of appliances, optimise patient treatment time and reduce laboratory costs; whereas good quality study models are paramount for diagnosis and treatment planning, as well as monitoring of treatment progress of patient cases.

II. MATERIALS AND METHOD

Sample and data source

This study was carried out at the orthodontic laboratory at Dundee Dental Hospital and School between12 August to 7September 2021. All alginate impressions received by the laboratory within this period were included in this study. The impressions were undertaken by all clinicians including dental students and nurses. Impressions sent by all departments including Orthodontic, Paediatric Dentistry, Restorative Dentistry, Oral Medicine and Oral Surgery to the orthodontic laboratory were included in this study.

Methodology: A data collection pro forma consisting of 12 essential criteria for good quality impression was formulated.As there are no established gold standards on the quality of dental impressions, the following essential criteria were formulated based on previously published audits[8-10] and following discussions between the author and laboratorytechnicians:

1.No air blows
2.No drag marks or tears
3.Correct size of stock tray
4.Clear record of surfaces of all teeth including terminal molars
5.Record of adequate sulcus depth
6. Record of hard palate (for upper impressions)
7. Midline of arch correctly positioned
8. No visible stock tray within the impression
9.No separation of material from tray
10. No grainy impression material
11. No thin impressions on labial surface
12. Free of blood, plaque and food debris

There is a comment box in the pro forma in which the technicians could note any comments regarding the impressions that were not on the list. The form also consisted of other essential information such as the type of intended laboratory work requested, completeness of the laboratory prescriptions received and whether the impression require any further adjustments by the technicians.

The pro forma was completed by four dental technicians who assessed all the impressions sent to the orthodonticlaboratory to determine if the impressions meet the essential criteria.

III. RESULTS

Ninety-nine consecutive alginate impressions (n=99) received by theorthodontic laboratory between 12 August to 7September 2021 were evaluated by the technicians. 99 forms were returned by the technicians and the results were analysed. Figure 1 outlines the distribution of impressions received based on department. 71.7% of the impressions were sent by Orthodontic Department, followed by Paediatric (15.2%), Oral Medicine/ Oral Surgery (8.1%) and Restorative (3%). 2% of the returned forms did not have information about the department recorded.

Figure 2 demonstrates the distribution of impressions based on staff level. The impressions were undertaken by a wide range of clinicians. 35.4% were carried out by consultants, followed by specialty dentists (24.2%), nurses (19.2%), registrars (11.1%), dental core trainees (5%), students (3%) and therapist (1%). One form did not have information about staff level recorded.

Data analysis showed that 18.2% of the impressions require further adjustments by the technicians (Figure 3). Although l3.1% of the impressions required minimal adjustments and 3% of them required major adjustments, all of the impressions were useable and no new impressions were required. 47.5% of the laboratory prescription forms had missing items. The majority of missing information on the laboratory prescriptions were the time of disinfection and the date when the laboratory work is required.

Figure 4 demonstrates the distribution of the type of laboratory work prescribed by clinicians. In certain cases, more than one type of laboratory work was prescribed. 47.5% of the impressions were for

study models, whereas 21.2% of the impressions were for fabrication of removable appliances such as Hawley appliances, space maintainers and bite raising appliances. This is followed by fabrication of Retainers such as vacuum form retainers, Components of fixed appliances such as Transpalatal Arch appliance (TPA) and Functional appliances such as Twin Block at 20.2%, 11.1% and 6.1%, respectively.

Figure 5 outlines the distribution of impressions based on essential criteria. The criteria that were met by the majority of the impressions were correct position of midline on the impression (92.9%), correct size of stock tray (90.9%) and no grainy impression material (90.9%).

In terms of the areas needing the most improvement, 60.7% of the impressions had visible areas of the stock tray within the impression, indicating there was insufficient impression material on certain areas. 37.4% of the impressions had thin impressions on labial surfaces and 25.3% of the impressions had drag marks or tears.

IV. DISCUSSION

Although18.2% of the impressions require further adjustments by the technicians, all of the impressions were technically acceptable for the intendedlaboratory work. 60.7% of the alginate impressions had visible areas of the stock tray within the impression and 37.4% of the impressions had thin impressions on labial surfaces. To avoid the deficiencies found in the impressions, more care must be taken in selecting the correct tray size, loading impression material on the trays, careful insertion of the trays in the mouth and holding impression in place with light pressure.When the tray is seated during impression taking, pressure should be released immediately and the tray is held lightly in place to prevent unseating.[11] It is crucial to release pressure as soon as the tray is seated. The setting of alginate materials starts from the tooth surface to the impression tray. Pressure will result in the impression to set under strain.[11]These strains will be released upon removing the impression from the mouth, resulting in distortion and inaccuracy in the cast. In addition, manual manipulation of the soft tissue especially the labial flange is imperative to allow the alginate to flow into the sulci and record the details.[11]

It is found that 25.3% of the impressions had drag marks or tears. In cases where there is severe angulation of the teeth, some impression material can be placed in the undercuts area prior to inserting the tray in the mouth. Occlusal surfaces of teeth should be blown off with an air syringe to remove debris and saliva, as well as reduce airblows. However, the teeth should not be left to dry completely as alginate material sticks to dried teeth as the thin film overlying the teeth is removed.[11] When the teeth surfaces are dry, the alginate radicals in the impression material form chemical bonds with hydroxyapatite crystals of the enamel; thereforethe alginate impression tears upon removal.[12] Asking the patient to rinse with water and mouthwash mixture will eliminate mucin and lower the surface tension, thereforeremoving air bubbles.[11]

In addition, defects or bubbles on a dental cast could be caused by an insufficient amount of impression material or air trapped between the impression material and the arch at tray insertion. These defects can be minimised by placing alginate material around the teeth and into the vestibule prior to inserting the impression tray.[13] In patients with deep palates, some impression material can be placed into the depth of the palatal vault. Even though 14.1% of the impressions assessed in this study contained airblows in certain areas such as the palate, it is noted that they would still result in an acceptable study model.

17.2% of the impressions assessed did not have a record of all surfaces of the teeth.

Mixed alginate material should be placed onto the occlusal surfaces with a gloved finger to fill the occlusal grooves to allow accurate replication of the occlusal tooth anatomy.[11]

47.5% of the laboratory prescription had missing items. The majority of missing information on the laboratory prescriptions were the time of disinfection and the date of finish. Although it is most likely that all of the impressions were disinfected, this was not detailed on the laboratory form. Clinicians should complete laboratory forms fully and detail evidence of disinfection. Laboratory technicians should consider disinfecting any work that does not show evidence of disinfection.[8]

There are a few limitations to this study. The assessment criteria used in this study is strict as certain features may be present on the impressions but not clearly defined were marked as absent.The criteria for measuring the quality of impressions need to be modified. In addition, the assessment process is subjective. Four technicians were the assessors in this study. More education and calibration can be carried out to minimise bias among assessors.

V. CONCLUSION

Undertaking good quality impressions is an important part that can often be overlooked. Dental

impressions are an important part of dentistry in various areas including diagnosis and treatment planning in orthodontics and restorative dentistry. Even though 3D scanning and digital dentistry are becoming increasingly popular, conventional impressions techniques are still being used in most dental schools and dental practices. Alginate impression remains an economical option and easily manipulated impression material. In this study, all of the impressions were technically acceptable for the intended laboratory work although there were areas requiring improvement. This study highlights the importance of good collaborative effort between clinicians and laboratory staff in producing high-quality dental appliances and study models.

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Figures

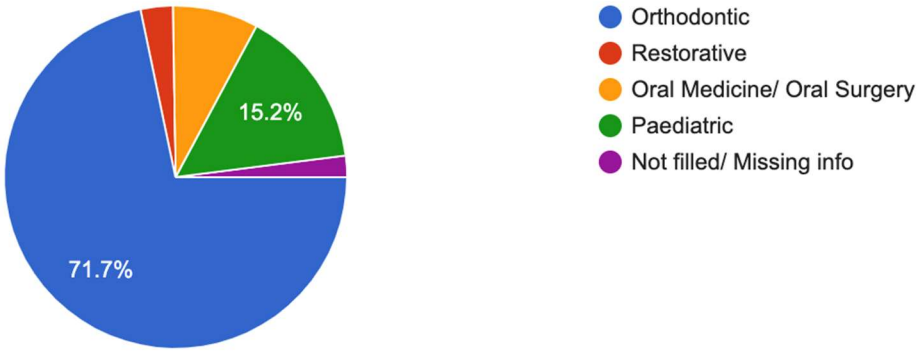

Figure 1: Distribution of impressions received based on department

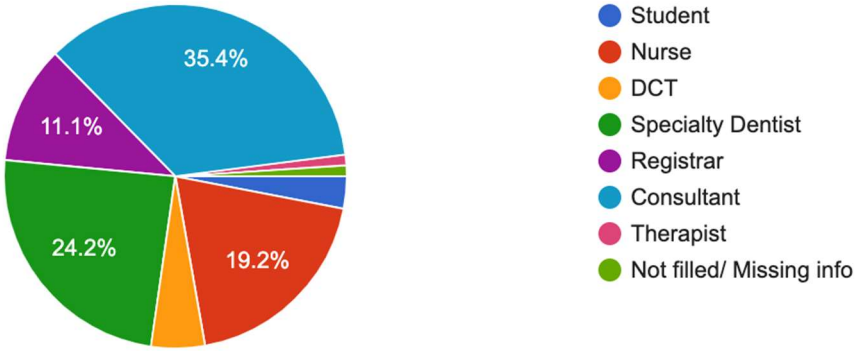

Figure 2: Distribution of impressions based on staff level

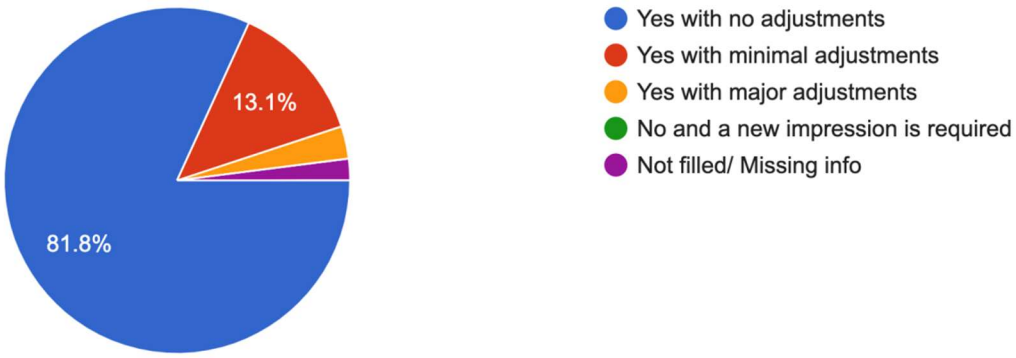

Figure 3: Distribution of impressions based on the criteria‘was the impression useable?’

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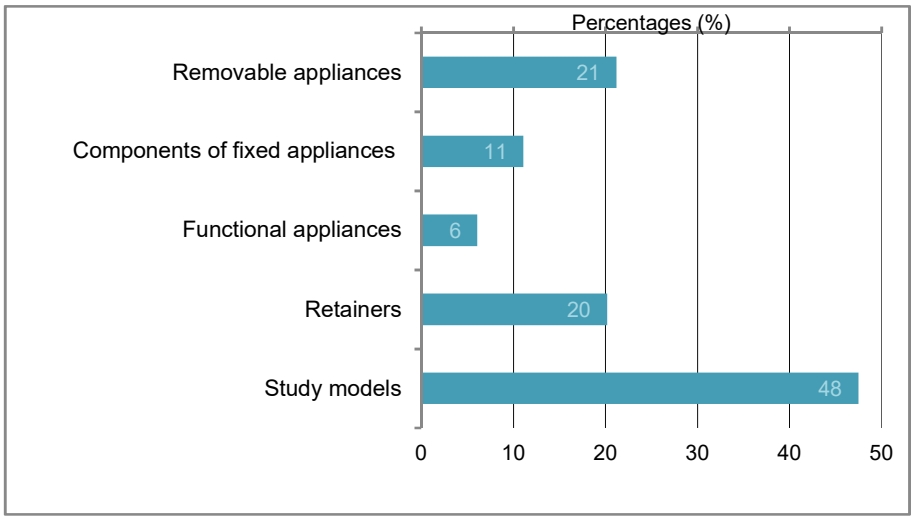

Figure 4: Distribution of the type of laboratory work prescribed by clinicians

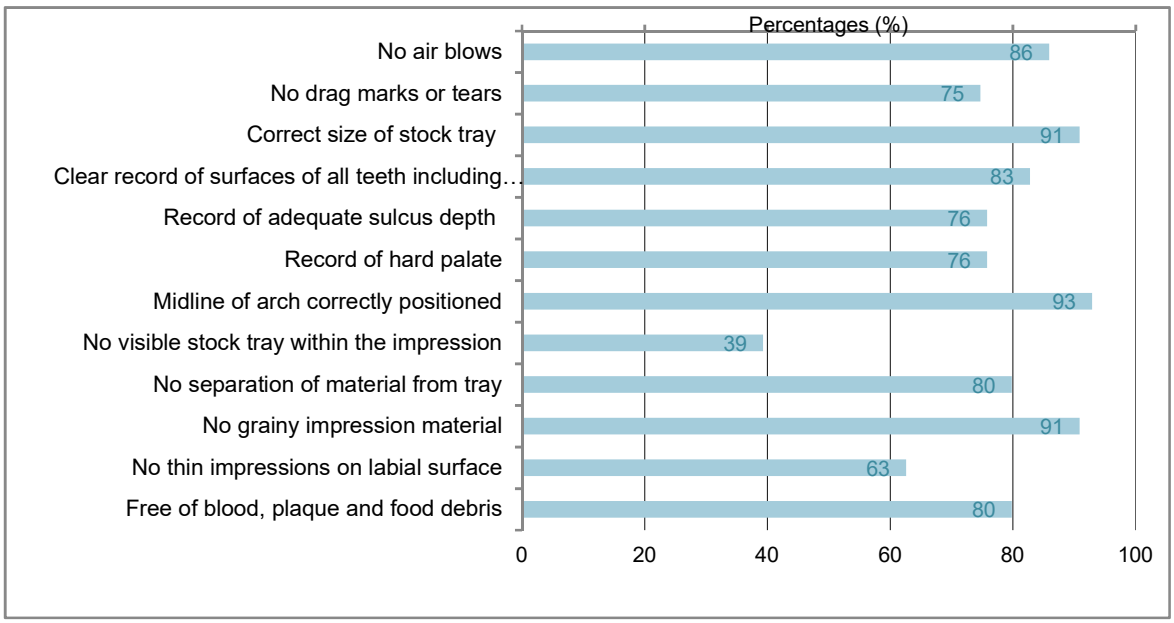

Figure 5: Distribution of impressions based on essential criteria