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Service evaluation of frequency of recording of jaw relations during construction of conventional removable partial dentures in general dental NHS practice with case presentations highlighting potential for digital denture construction

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**Abstract**

**Aims:** To establish the incidence of general dental practitioners recording jaw registrations in primary dental care practices when providing removable partial dentures (RPDs).

**Method:** A random sample of 271 partial dentures made by 16 general dental practitioners (GDPs) across four NHS dental practices were evaluated prospectively. The following was assessed: number of teeth replaced, whether jaw registration was

undertaken, requirement of jaw registration retakes, material used to record jaw registration and number of denture adjustment appointments required after the denture fit stage. Telephone interviews with five correlating dental technicians were undertaken to establish their opinions on quality of the jaw registrations plus their material and technique preference.

Main findings: Jaw registrations were not carried out in 26.5% (n=72) of partial dentures provided. Jaw registration was not recorded in 46% (n=37) dentures replacing  $\leq 3$  teeth and 65% (n=34) dentures replacing  $\geq 4$  teeth. When a jaw registration was carried out, GDPs utilised wax rims in 99% of cases (n=269). Of the dentures where a jaw registration was recorded, 14% (n=28) required a further denture adjustment appointment; 64% (n=46) of dentures which did not have a jaw registration recorded required at least one further denture adjustment appointment. Dental technicians unanimously preferred a squash-bite wax record block, with center and canine position lines marked and cast models tied with elastic bands. Conclusion: Jaw registration is not routinely carried out by GDPs, with time pressures and lab fees stated as the main cause. Overall, it was found that recording a jaw registration reduced the number of denture adjustment appointments required for the partial dentures provided.

**Keywords:** Jaw Registration, Digital Dentures, Partial Dentures, Denture Adjustment

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New digital scanning technology may be the solution to addressing barriers faced by GDPs in General NHS practice, producing high quality dentures in an efficient manner. Digital dentistry has been utilised for the fabrication of fixed dental prosthesis for many years, and now has been introduced for removable prosthesis. Computer-aided design and computer-aided manufacturing (CAD/CAM) can be used to fabricate prosthesis by additive measures, rapid prototyping, or subtractive measures, computer numerical control (CNC) machining and milling.<sup>1</sup> During the working scans the jaw relation is recorded simultaneously; this negates the need for arranging further appointment to record jaw registration. Therefore, digitally fabricated removable partial dentures (RPDs) produced via CAD-CAM technology, 3D printers, scanners and industrial casting can reduce the number of steps required for denture fabrication and number of patient visits. Dentures can then be provided in a shorter time period, as shown in Case 1 (see Figure 3).

Digital dentures can also be economically beneficial as reduced labour is required.<sup>2</sup> The initial set up cost of digital dentistry is substantial, however laboratory steps are

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replaced and chairside time is reduced.<sup>3</sup> Due to reduced handling, it has also been found that digital dentures harbour reduced microorganism.<sup>4</sup>

Edentulous spaces can lead to patients experiencing problems with function; aesthetics and psychological impact,<sup>5</sup> leading patients to seek tooth replacement options. The process of making dentures is technique sensitive and relies on technical skills involving multiple clinical steps, clear laboratory communication as well as management of patient expectations. Jaw registration is an integral part of such denture fabrication. It allows the occlusal vertical dimension (OVD), intercuspal position (ICP)/retruded contact position (RCP) and soft tissue support to be planned. Clinicians can also communicate desired tooth positioning to the laboratory by utilising clinical biometric guides and communicating patient preferences.<sup>6</sup> Optimum function, comfort, aesthetics and patient satisfaction of the final dentures can then be achieved. The British Society of Prosthodontics (BSSPD) has set guidelines on the fundamental requirements of optimum jaw registration.<sup>6</sup> BSSPD guidelines state jaw relationships should be recorded using occlusal rims (when appropriate).<sup>5</sup> Casts should be mounted and studied on an articulator and a rigid base registration material should be used. Recording of the pre-treatment occlusion by use of simple 2D system is advised by the *British Dental Journal (BDJ)* published guidelines for good occlusal practice.<sup>6</sup>

### **Aims**

The aim of this service evaluation was to assess the current jaw registration practice of GDPs when providing patients with partial dentures in primary care general NHS practice.

### **Objectives**

The objectives are to assess whether jaw registrations are routinely being recorded during partial denture fabrication and to establish GDPs and lab technicians preferred method to record jaw registrations. To also evaluate the number of denture adjustment appointments following denture fit.

### **Methodology**

A data collection sheet was piloted retrospectively across four NHS practices in North-East London; 16 dentists constructed 40 partial dentures over six months. Following amendments to the pilot, a random sample of 271 partial dentures made by the same dentists and practices were evaluated prospectively, via

clinical records using the standardised collection sheet. Written feedback questionnaires were sent to the correlating dental technicians. Short telephone interviews were carried out with those dental technicians who did not respond to the written questionnaires. Five respective dental technicians were contacted to establish their opinions regarding the quality of the jaw registrations received from GDPs and their preference of material and technique. The 16 GDPs were asked to provide feedback on attitudes regarding recording jaw registrations for partial dentures in general NHS practice.

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## Results

Two hundred and seventy one dentures were analysed (80 replacing 1-3 teeth, 81 replacing 4-6 teeth, 62 replacing 7-10 teeth and 48 replacing more than 10 teeth). Twenty of the dentures were cobalt-chrome (Co-Cr) and two hundred and fifty one were acrylic. Overall, of the 271 dentures, a jaw registration was not carried out in 26.5% of cases (n=72). The main contributing denture was replacement of  $\leq 3$  teeth, were in eighty dentures a jaw registration was not recorded in 46% (n=37). Eighty one dentures provided replaced 4-6 teeth and of these 13.6% did not have a jaw registration recorded (n=11). Of the one hundred and ten dentures that replaced 7 teeth or more, 21% did not have a jaw registration carried out (n=23). A jaw registration was recorded for 100% (n=20) cobalt chrome partial dentures provided, regardless of the amount of teeth being replaced. The material of choice to carry out a jaw registration was wax rims which was used in 269 cases, and in only two cases was heavy bodied silicone was used as an alternative medium. None of the dentists utilised digital jaw registration methods when making any of the partial dentures. In 4.4% (n=12) of cases the laboratory requested a repeated jaw registration, due to ambiguity of correct occlusal relationship. In dentures where jaw registration had been carried out (n=199), 14% (n=28) required a further denture adjustment appointment (see Figure 1). In dentures where a jaw registration was not carried out (n=72), 64% (n=46) required a further adjustment appointment, of these cases 33% required two or more appointments (n=15) (see Figure 2).

Results of the telephone interviews confirmed that the dental technicians unanimously preferred a squash-bite wax record block, with centre and canine position lines clearly marked and cast models being secured with elastic bands.

## Intervention

Guidelines set by the British Society for the Study of Prosthetic Dentistry (BSSPD) on occlusal registrations<sup>5</sup> were presented to all dentists across the four NHS practices, with a practice policy and laboratory proforma set up based on this guideline. The laboratory preferred occlusal registration methods was also discussed. Dentists were advised to re-check wax rims once cooled, ensuring occlusal conformation to minimise the need for repeat jaw registration.

### **Clinical Case Presentations**

Time constraint, has been highlighted as part of this service evaluation as one barrier to carrying out a Jaw Registration for partial dentures in NHS General practice. Can new digital methods overcome such time pressures in NHS practice?

Two clinical case presentations are shown whereby digital dental scanning has improved the speed and effectiveness of removable partial denture construction.

The first case (see Figure 3) has used a fully digital workflow with an intra-oral scan of the maxillary and mandibular arches, the existing denture *in situ* and the occlusion all on the first visit, followed by a fit next visit to provide an accurately fitting partial denture in two visits, which required no further adjustment. This saved time as the usual construction method this would have involved six visits (primary impressions, secondary impressions, metal framework try in and secondary jaw registration, try-in and fit).

**Figure 3. Case with fully digital Removable Partial Denture completed in two visits (Technical work by Ashley Byrne)**



The second case presentation (see Figure 4) shows example of scanning the patient's existing removable partial denture to fit new crowns around an existing partial denture. This allows the patient to only be without their denture for one hour. The printed version of the denture was used to facilitate the jaw registration.

**Figure 4. Scanning patient's existing removable partial denture (Technical work by Ashley Byrne).**

4a Image showing digital design of metal frameworks for new metal ceramic crowns on the maxillary right premolars and first molar (green) to be fitted around an pre-existing removable partial denture (pink) which has been scanned and superimposed onto the digitized version of the master impression (white). This allows precise design of the new crowns to fit around the existing partial denture, without the need to remake the denture.



Figure 4b Image showing the physical model used to layer the porcelain on the buccal aspect of the new crowns. A printed version of the scanned pre-existing RPD has been printed (orange) in PMMA and fitted to the conventional gypsum master case (cream) in order to check the fit of the RPD around the new metal ceramic crowns. The metal frameworks were additively manufactured using Selective Laser Melting as per the digital design in figure 4a.



## Discussion

There are many materials available to record jaw registration including, wax, zinc oxide and eugenol (ZOE) and Polydimethylsiloxane of different consistencies. The



BSSPD guideline highlights the advantageous qualities of ZOE impression paste or rigid silicone registrations, as it allows relocation of the rims if detachment occurs during transportation.<sup>5</sup> Effective communication with the dental laboratory is key to gauge their preference on jaw registration material. The preferred mode of packaging should also be discussed with technicians to reduce risks of jaw record deformation during transportation.

During this service evaluation it became evident that clear and concise communication with the dental laboratory allows better rapport between the team, as well as minimising repeat of procedures. Prostheses should aim to allow biologic and functional harmony with the supporting tissues and remaining teeth.<sup>7</sup> The jaw record is a vital mode of communication between the dentist and dental technician, allowing construction of harmonious occlusion.<sup>8</sup>

Our findings highlight that many practitioners did not record jaw registration due to the barrier of clinical time constraints, however the need for final denture adjustment was greater in cases where jaw registration had not been recorded.

Following practice meetings held in the participating practices covering the BSSPD guidelines, there was increased motivation from dentist to recording a jaw registration. However, due to their perceived pressures from working in NHS practice, it underlined the difficulties involved in changing practitioner's habits long term.<sup>9</sup> It has been established in the literature that using two or more educational interventions can be effective in changing practice.<sup>10</sup>

Jaw registration is an integral step of denture fabrication to ensure optimum wear of dentures. Moving forwards, sustainable techniques in denture fabrication must be considered to ensure denture quality is not compromised. It is important to understand the clinical indication for jaw registration. If the patient has 'an adequate number of teeth, stable intercuspal position, no signs and symptoms of trauma to the occlusion and the goal of maintaining occlusal vertical dimension', the casts can accurately be articulated by hand; in the absence of jaw registration material which may introduce occlusal error.<sup>11</sup>

A literature review comparing computer-engineered and conventional complete dentures found digital fabricated dentures carry the advantage of improved retention

due to the lack of polymerisation compared to conventional dentures.<sup>12,13</sup> The constituents of polymers used in dentistry are constantly evolving, allowing increased biocompatibility, durability, aesthetics, elasticity as well as reducing costs associated with metal.<sup>14</sup> Case 1 demonstrates polymer utilisation in digital dentistry, which can allow for more precise fitting dentures (see Figure 3).<sup>14</sup>

Retention is further enhanced in digital partial dentures, as retentive areas are registered through the digital impression.<sup>15</sup> This is then incorporated into the denture design reducing the need or extent of tooth preparation, rendering digital partial dentures a conservative approach with reduced allocation of chairside time.<sup>16</sup> Increased retention and fit of clasps has also been reported using laser sintering and milling compared the cast technique.<sup>17</sup> A systematic review found the final fit of digital partial dentures was excellent, where visual, tactile and silicone registration was used to assess fit.<sup>18</sup>

As well as reduced clinical time and improved retention, digital dentures offer rapid fabrication of spare or replacement dentures. The digital data is saved on the database and can be fabricated without the need for patients to attend the practice.<sup>19</sup>

Due to the multiple and technique sensitive steps of conventional denture fabrication, the outcome of denture quality is varied between clinicians. A randomised control trial reported a correlation between increased denture adjustment required and reduced number of years of experience.<sup>20</sup> Statistical analysis of an in vivo study concluded the inter-operator reproducibility using digital impression technique may be better compared to the conventional silicone impression technique.<sup>21</sup> The user-friendly digital technique may therefore reduce denture quality discrepancy between general dental practitioners, with studies showing increased quality control reported by clinicians and technicians.<sup>22</sup>

A potential service evaluation incorporating more GDPs would provide a greater understanding on GDPs technique on denture fabrication. The displacement of mucosa under denture has been reported to be 20 times greater than teeth via periodontal membrane. It would therefore be beneficial to use Beckett's classification<sup>23</sup> to record denture support in order to ascertain correlation between denture support and denture adjustment appointments.<sup>22</sup> Recording whether denture adjustments to the occlusal surfaces were required due to interference in the static occlusion or lateral excursion would be valuable. A high number of cases of denture

adjustment due to interference in lateral excursion may indicate the need for balanced articulation by using a facebow record.<sup>6</sup>

### **Conclusion**

It is evident that jaw registration is not routinely carried out during partial denture fabrication, especially for dentures replacing six teeth or fewer. It is important to use clinical judgement to assess whether jaw registration is required. It was found following this service evaluation that overall, recording a jaw registration reduced the number of denture adjustment appointments. Consensus on the preferred method for jaw registration was a squash-bite wax record by dental technicians, with emphasis on presence of centre and canine position lines and elastic bands utilised to secure the study models. Repeating of the jaw registration can be reduced by securing the study models optimally during transport as well as reassessing a jaw registration record at chair side upon cooling. Digital dentures may be the solution to resolve the barriers of time constraint and multiple visits, serving to benefit both patients and GDPs in NHS general practice.

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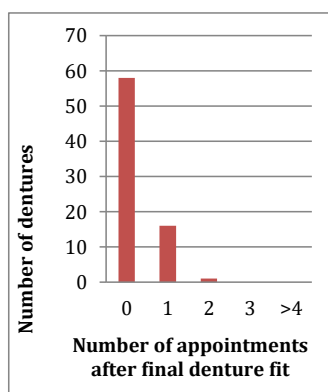


Figure 1 Denture adjustment appointments required for dentures fabricated with occlusal registration

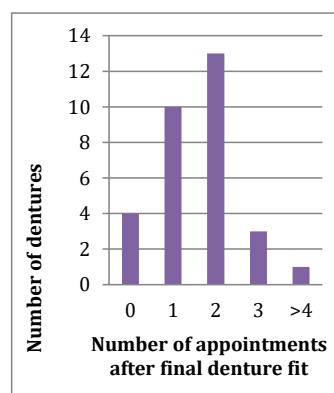


Figure 2 Denture adjustment appointments required for dentures fabricated without occlusal registration