How long does it take for the Occlusion to Re-establish Following the Placement of Restorations at an Increased Occlusal Vertical Dimension? A Literature Review.

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Abstract

Purpose: This literature review aimed to investigate predictability of re-establishment of the occlusion following placement of restorations at an increased OVD, duration and to assess the quality of the available evidence.

Methods: An electronic search of articles using MEDLINE (1946-01/2019), EMBASE (1974-01/2019) and the Cochrane databases was undertaken. Search terms included dental restoration, vertical dimension and time. Studies involving placement of restorations at an increased OVD and recorded the time taken for the occlusion to re-establish were included. Eligibility assessments were carried out independently by two reviewers who also undertook independent extraction of predefined data fields, including study quality indicators.

Results: The search provided 61 results with 11 being relevant. A further 5 papers were identified for full text analysis. 4 papers used similar data from previous studies and 3 were excluded after full text assessment. A final total of 9 papers were included in the review. It was indicated that the technique of placing restorations at an increased OVD appears to be clinically predictable in terms of re-establishment of occlusion and appears to occur most rapidly in younger patients.

Conclusion: The time taken for the occlusion to re-establish was between 15 days to 24 months. However, there is a need for prospective studies to evaluate the process in terms of success, predictive variables and specifically how long the process takes and this information would be helpful for both clinicians and patients, so that they know what to expect before embarking on a treatment.

Keywords: Literature Review, Restorations, Increased Vertical Dimension

1. Introduction

Modern techniques in restorative dentistry emphasise the preservation of healthy natural tooth tissue and a move towards a minimally invasive (MI) approach [1]. One such technique, which minimises the biological cost to the patient is the placement of bonded restorations at an increased occlusal vertical dimension (OVD) with minimal or no removal of the existing tooth structure.

In the case of patients who may present with tooth-wear, which has resulted in the loss of enamel and dentine, through pathological processes such as erosion, it is logical to try to restore the missing tooth structure without further removal of tooth tissue and this can be achieved using an “additive approach” with direct composite resin. It has been shown that placing direct composite resin at an increased occlusal vertical dimension to manage localized anterior tooth wear can result in an acceptable outcome over a period of 10 years [2].

In the case of patients who present with missing teeth, adhesive, or Resin-Bonded Bridgework (RBBs) can often be placed with no preparation of the abutment tooth thus reducing the biological cost to the patient to close to zero. There are some specific exceptions described [3,4], such as for the creation of guide planes to limit the path of insertion by minimal preparation within enamel only but not involving any preparation occlusally, or into dentine. An additional benefit for the patient is that direct bonding to enamel results in more predictable adhesion and reduced biological cost to the patient, whereas tooth preparation may lead to dentine exposure and less predictable adhesion and several studies have demonstrated a successful outcome for this approach [5,6].

In regards to what happens when a restoration has been deliberately placed at an increased vertical dimension, Dahl et al. [7,8]
studied the effect of placing a removable anterior bite plane at an increased OVD and they attributed the reestablishment of occlusion primarily to overereption of the posterior teeth, but also to a relative intrusion of the anterior teeth. The effect is now more often attributed to a process of dento-alveolar compensation and has subsequently been referred to as the “Dahl effect”. This phenomenon of axial tooth movement is well documented and published, perhaps most notably, as mentioned above, in the work carried out by Dahl et al. [7,8], and thereafter by others, as discussed below, often using both fixed and removable prostheses to create the increased vertical dimension. Work as early as 1962 by Anderson [9] also demonstrated their use in treating a class 3 incisor relationship [10].

The amount of time it takes for the re-establishment of occlusal contacts following placement of restoration(s) at an increased OVD is unclear, but is obviously very important from a clinician’s point of view as well as for patients. The return to function will be of paramount importance to the patient and therefore it is useful to have reliable information about the process before embarking on treatment. Poyser et al. [10] suggested that posterior contacts are re-established after approximately six months, with some clinicians, such as Zee and Amerongen [12], reporting less and others reporting significantly longer periods of up to 18-24 months [13,14]. It has also been suggested that there may be a limit to the eruptive potential in some cases [15].

With attention to fixed restorations, the aim of this literature review was to investigate the time it takes for the occlusion to re-establish after a restoration is placed at an increased OVD and will attempt to answer the following questions:
1. How predictable is the re-establishment of occlusion following the placement of restorations at an increased occlusal vertical dimension?
2. How long does it take for the occlusion to re-establish and stabilise following the placement of restorations at an increased occlusal vertical dimension?
3. What variables (for example the age of the patient, reason for increasing OVD, position of restoration in the arch), if any, relate to the amount of time for the occlusion to re-establish or predictability of this occurring?
4. For points 1, 2 and 3, what is the quality of the available evidence?

2. Materials and methods

Search Strategy:

Studies were identified by searching electronic databases, scanning references and discussion with relevant subject experts. A literature search strategy was developed using medical subheadings (MeSH) and free text searches. The Medline (1946-01/2019) and Embase (1974-01/2019) strategy was then reviewed by a librarian who had no other involvement in the review. The Cochrane database was also reviewed. Eligibility assessments were carried out independently by two reviewers who also undertook independent extraction of predefined data fields, including study quality indicators. Data extraction was carried out using a data extraction sheet with predefined data fields, where data items were shown as column headings (Table 1). This was completed by one review author and checked by a second. Again, any discrepancies were discussed and resolved by consensus. Information from each source including (1) Study details (Author, year, study design); (2) Increased OVD (Method of increase in OVD and amount of increase in OVD); (3) Aetiology; (reason for placing restorations?); (4) Period of follow-up; (5) Teeth treated (area and number of teeth); (6) Patient details (Number of patients, Male: Female ratio and age range); (7) Success rate; (9) Results (Mean and Range of time taken for Occlusion to re-establish); (10) Study weaknesses.

Inclusion Criteria:

1. Human clinical studies including randomised controlled clinical trials, controlled clinical trials, prospective and retrospective studies.
2. English language publications
3. Dental language publications
4. Time not included for the occlusion to re-establish
5. Studies which have used previous data but with a different follow-up period
6. Case reports and case studies
7. Studies without an abstract

Exclusion Criteria:

1. Animal studies
2. Publications not written in English
3. Implant-retained restorations
4. Time not included for the occlusion to re-establish
5. Studies which have used previous data but with a different follow-up period
6. Case reports and case studies
7. Studies without an abstract

3. Results

3.1. Search results

The initial search resulted in 83 citations (33 Medline, 50 Embase), which left 69 after duplicates were removed. From this 58 were not relevant to the subject so were excluded based on the titles and abstracts, leaving 11 papers for inclusion on the study. Following bibliography searching a further 5 papers were identified.

Full texts of the 16 papers were assessed to identify those that recorded the amount of time it took for the occlusion to re-establish following the placement of a restoration at an increased OVD. Of the 16 full texts, 4 had used the same data from previous studies but reported on a different follow-up. The first of which, was the Dahl and Krogstad 1982 [8] paper which included a patient that was used for the Dahl and Krogstad 1985 paper [16]. Therefore, the latter paper was excluded. Similarly, a paper by Gulamali et al. [2] used data from a previous study by Redman et al. 2003 [17]. Hemmings et al. [18] and Darbar and Hemmings [19,20] all used data from the same patient group. The Hemmings et al. [18] paper, which looked at the results at 30 months was used. Yip et al. [2], Dyer et al. [22] and Hamburger et al. [23] were also excluded after full text assessment as they did not meet the inclusion criteria for recording the amount of time taken for the occlusion to re-establish after placement of restorations. This literature review was based primarily on retrospective and prospective cohort studies as there were an absence of randomized controlled trials and total of 9 studies were included. This has been schematically represented in the following adaptation of the 2009 prisma flow diagram, (Fig. 1) [24]. The studies characteristics and their relevant findings are shown in Tables 1 and 2 respectively.
Table 1. Data Collection

<table>
<thead>
<tr>
<th>Author</th>
<th>Year Study Design</th>
<th>Method of increase in OVD</th>
<th>Aetiology</th>
<th>Area/Teeth treated</th>
<th>Number of patients</th>
<th>Success Rate</th>
<th>Time range for occlusion to re-establish (months)</th>
<th>Mean time for occlusion to re-establish (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gow et al [25]</td>
<td>2002 Prospective</td>
<td>Indirect fixed anterior palatal resin veneers 1-4</td>
<td>Tooth wear</td>
<td>Minimum 2 years</td>
<td>Anterior maxilla and mandible</td>
<td>12</td>
<td>Not given</td>
<td>10/12</td>
</tr>
<tr>
<td>Poyser et al [11]</td>
<td>2007 Prospective</td>
<td>Direct anterior composite build up 0.5-5</td>
<td>Tooth wear</td>
<td>2.5 years</td>
<td>Anterior maxilla and mandible</td>
<td>6-12</td>
<td>18 total, 15 as fixed dahl 11:4 (14:4) 31-75 (51) [31-75 (52)]</td>
<td>14/15 (in fixed dahl sub group)</td>
</tr>
<tr>
<td>Harley and Ibbetson [26]</td>
<td>1993 Prospective</td>
<td>Indirect cast restorations bonded to unprepared teeth</td>
<td>Amelogenesis (7) or dentino genesis imperfecta (5)</td>
<td>10-54 months</td>
<td>Four first permanent molars in 11 patients, upper and lower incisors in 1 patient 4 in 11 patients, 8 in 1 patient</td>
<td>12</td>
<td>not given</td>
<td>12/12 maximum of 3</td>
</tr>
<tr>
<td>Gough and Setchell [13]</td>
<td>1999 Retrospective</td>
<td>Both fixed (78%) and removable (22%) appliances Not given</td>
<td>Tooth wear</td>
<td>Up to 14.1 years, median 4.43 years</td>
<td>68% anterior, 32% posterior, 76% maxillary, 24% mandibular 1-7</td>
<td>45</td>
<td>21:24 20-70 (37)</td>
<td>43/45</td>
</tr>
<tr>
<td>Zee and Amerongen [12]</td>
<td>2010 Prospective</td>
<td>Preformed metal crowns cemented using the Hall Technique 1:9:1</td>
<td>Caries</td>
<td>Carious primary molars At least 1 (not specified)</td>
<td>56</td>
<td>not given</td>
<td>8/8</td>
<td>15-30 days not given</td>
</tr>
<tr>
<td>Hemmings et al [18]</td>
<td>2000 Prospective</td>
<td>Direct anterior composite restorations 1-4</td>
<td>Tooth wear</td>
<td>30 months (mean)</td>
<td>Anterior maxilla and mandible 4-12</td>
<td>16</td>
<td>Not given</td>
<td>15/16</td>
</tr>
<tr>
<td>Redman et al [17]</td>
<td>2003 Retrospective</td>
<td>Fixed direct (134) and indirect (91) anterior composite restorations not given</td>
<td>Tooth wear</td>
<td>5 months - 6 years</td>
<td>Anterior maxilla and mandible 31</td>
<td>22-9 15-70 (not given)</td>
<td>31/31 (61% complete, 39% partial)</td>
<td>1.5-18.5 7</td>
</tr>
<tr>
<td>Anderson [9]</td>
<td>1962 Prospective</td>
<td>Continuously worn removable metal cap</td>
<td>Nil</td>
<td>Lower right first molar 1</td>
<td>5</td>
<td>Not given</td>
<td>5/5</td>
<td>23-41 days not given</td>
</tr>
<tr>
<td>Dahl and Krogstad [8]</td>
<td>1982 Prospective</td>
<td>Anterior removable Co-Cr bite raising appliance 1.8-4.7</td>
<td>Tooth wear</td>
<td>Up to 14 months</td>
<td>Maxillary anterior Palatal (3-3)</td>
<td>20</td>
<td>14:6 18-50 (34.7)</td>
<td>20/20 adequate, 14/20 planned</td>
</tr>
</tbody>
</table>

3.2. Study characteristics

The included studies comprised of 7 prospective and 2 retrospective studies carried out both within the hospital setting and elsewhere. The dates of publication ranged from 1962 to 2010 and the median publication date was in the year 2000.

There were significant differences between all the studies in terms of their aims and the methods used. However, all included the placement of dental restorations at an increased OVD and recorded the amount of time that it took for the remaining occlusal contacts to re-establish. Not all the included studies made all relevant data available. Few provided clinical data for individual patients such as the magnitude of increase in vertical dimension, or the time taken to re-establish the occlusion in each patient. This, combined with the different reasons for treatment in each study as well as the different types of treatment, meant that there was lack of uniformity between studies, making drawing conclusions more challenging.

Different restoration types were used, including both fixed and removable prosthesis. In terms of fixed restorations, both direct and indirect techniques were used.

There were different methods of recording the re-establishment of occlusion. Three used shimstock contacts between teeth [11,17,18], one looked at differences between reference points on teeth such as canine tips [12], and another example used enamel grooves placed on teeth [9]. A study by Dahl and Krogstad used tantalum rods placed in the basal bones analysed radiographically [8]. Harley and Ibbetson assessed OVD using overbite and overjet measurements on models taken pre-operatively, immediately post operatively and after occlusion was re-established [26]. Two of the studies did not specify how they assessed the occlusal re-establishment [13,25]. Because of the varying methods of measuring occlusal re-establishment there was no cross-study consensus on what would define the point at which the occlusion had re-established.

The longest follow up period was 2.5 years [11], which in some studies was before occlusion had fully re-established in all patients. Thus, no longer term follow up of these patients for whom occlusion had not re-established was available.

The stated increase in OVD varied between studies from 0.5mm up to 5mm. Within each study there was also a range in the amount of OVD increase. The method of how this was measured was not specified in all studies. The data provided of the increase in OVD dif-
fered across the studies. Two of the studies did not give any measurement of the increase of OVD [13,18], an approximation was given in three studies [9,12,26], the range of increase in OVD was given in two studies [8,25] and only two studies provided case specific data on the amount of increase in OVD [11,19].

The most common aetiology of tooth surface loss across the included studies was non-carious tooth tissue loss and the treatment of tooth wear. Again, this wasn’t the case for all studies. Other aetiologies included amelogenesis and dentinogenesis imperfecta as well as dental caries. None of the studies included cases where adhesive bridgework had been placed 'high' in occlusion.

The number of teeth restored varied, not only across studies, but also within each study: Some involved several restorations placed at the increased OVD, whilst others used a single restoration to increase the OVD. The position of the restored teeth varied between studies with some looking only at anterior restorations, some just posterior restorations and some using a combination of both anterior and posterior restorations.

The number of patients in each study ranged from 5-56. However, in the Zee and Amerongen study, which involved 56 patients, only 8 were assessed at the full period of follow up at 30 days [12]. The second largest patient cohort was 45 [13]. No sample size power calculations were carried out for any of the studies.

Across all the studies there was a range in patient characteristics. The ages ranged from 5 to 75. Both male and female subjects were included in those studies, which provided this information, however this information wasn’t available for all studies. Two of the studies only looked at a young patient groups with the age ranges for these being 7-18 and 5-7 years old [12,26]. The other studies looked at a wider age range of adult patients.

3.3. Success rates

Of the 169 patients, which were followed up to the end of their respective study, 6 had failed to re-establish occlusion and 6 patients in the Dahl and Krogstad paper did not achieve the planned occlusal re-establishment and stabilization [8]. The 6 patients of the Dahl and Krogstad study had definitive restorations placed before occlusion had re-established, due to patients’ wish to have the final crowns made, although in these cases sufficient space had been created to make this possible [8]. For the 6 patients who failed to re-establish occlusion, the reason for the failure was clear in 2 cases: one had not continuously worn their removable appliance [13] and one had continued to wear a previous soft splint [25]. In the other four patients, the failure was less clear, Gow et al. [25] and Poyser et al. [11] talk about a lack of eruptive potential as a possible cause, whilst Hemmings et al. [18] imply that a gross malocclusion was a possible explanation. There was no clear reason why a second patient failed to achieve occlusal re-establishment in the Gough and Setchell study [13].

Three of the studies noted pre-molar occlusal re-establishment as either failing by the end of the study period or taking longer in the pre-molar area then for other teeth [11,18,19]. Poyser et al. [11] noted that where only partial occlusal re-establishment had occurred, it was the pre-molar region, which had incomplete occlusal contact. Lack of pre-molar occlusal re-establishment was also reported by Redman et al. [18] where just over third of the 31 subjects studied did not achieve occlusal contacts in the pre-molar region during the study period. Hemmings et al. [19] noted that of the posterior occlusal contacts, those between the last molars occurred first and the pre-molars last, at which point occlusion was judged as fully re-established.
### Table 2. Study Weaknesses

<table>
<thead>
<tr>
<th>Reference</th>
<th>Specific study Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gow et al [25] 2002</td>
<td>Localised anterior tooth wear patients only, no details on what occlusal information was recorded, no information/descriptions on how occlusion was assessed as re-established, no clinician(s) details given, no details on preventative regime, wear of restorations acknowledged but not accounted for in re-establishment of occlusion, no details of occlusal assessments carried out, no details on what was deemed as when posterior occlusion had re-established, wide range in increase in OVD, specific data for each case not given, exact details of teeth treated not given, study setting not clear, examiner info not clear, no statistical analysis related to re-establishment of occlusion, not clear what was deemed to be re-establishment of occlusion, 2 year follow up only and posterior occlusion of 2 who failed to achieve posterior re-establishment not monitored further.</td>
</tr>
<tr>
<td>Poyser et al [11] 2007</td>
<td>No specific details on which teeth restored (does state how many and anterior), anterior teeth treated only, 4 patients lost to follow up (not at clinical review day, explanations given), dental hospital setting, wide range in increase in OVD however this was recorded, no statistical analysis related to re-establishment of occlusion, wear of restorations not accounted for, no clear what was deemed to be re-establishment of occlusion nor what was classed as partial re-establishment, no specifics given, single clinician assessed and treated patients, details of preventative regime not given, follow up to 2.5 years.</td>
</tr>
<tr>
<td>Harley and Ibbetson [26] 1993</td>
<td>Mean time and full range for occlusion to re-establish not given, specific period of follow up unclear, dental hospital setting, all patients aged 18 and under, mentions thirteen patients when was only 12, increase in OVD for each case not clear, no statistical analysis related to re-establishment of occlusion, not clear what was deemed to be re-establishment of occlusion, approximation of increase in OVD given only with no case specific data.</td>
</tr>
<tr>
<td>Gough and Setchell [13] 1999</td>
<td>Hospital setting, retrospective audit from clinical records only so not all data available or was recorded, such as increase in OVD data not available, recall bias as some information collected by direct questioning of operator or supervisor who was involved with case, no restorations definitive and 22% placed were removable, end-point of treatment unclear; successful space creation not defined in terms of details, how much space, which teeth in occlusion etc. unclear. No data on the amount of increase in OVD, no statistical analysis related to re-establishment of occlusion, not clear what was deemed to be re-establishment of occlusion or how it was measured.</td>
</tr>
<tr>
<td>Zee and Amerongen [12] 2010</td>
<td>Selection bias; school children in rain forest in Suriname used, age range 5-7, patients all young and growth not accounted for, not all patients included at follow up so results limited to those followed up, only 48 children followed up at 15 days and only 8 patients assessed after 30 days. Individual follow up data for each patient not given, rather statistical analysis of Occlusion for the follow up patients is given, patient specific increase in OVD not only a mean was provided.</td>
</tr>
<tr>
<td>Hemmings et al [18] 2000</td>
<td>Hospital setting, tooth wear population only, localised anterior tooth wear with loss of interocclusal space only. No details on who recorded baseline patient study data such as OVD/RVD, pre-op occlusal investigations not stated, no information on how patient were randomly allocated to either of study groups, 2 different composite systems used, “minimal tooth preparation was carried out” to reduce sharp enamel edges, wide range in increase in OVD, posterior opening measured from wax record taken post operatively between first molar teeth but post op Shimstock contacts were assessed, not clear if this was also done pre-op as not mentioned, reviewed every 3 months after 1 month until occlusion re-established, no details of clinicians given, details of what criteria was classed as when “posterior occlusion was restored” not given, continued tooth wear in 3 patients acknowledged but not accounted for in statistical analysis, no statistical analysis related to re-establishment of occlusion, not clear how long the process of restorations which were lost and replaced took and this isn’t accounted for in time taken.</td>
</tr>
<tr>
<td>Redman et al [17] 2003</td>
<td>Hospital setting, retrospective analysis from patient records along with review of patient, patients seen on review and restorations were from 5 months to 6 years old, no data on the amount of increase in OVD, not clear how frequent follow up of patients were although time taken for posterior contact to re-establish was recorded in each subject, the paper acknowledges that wear of restorations may have played a part in results but this isn’t measured, no statistical analysis related to re-establishment of occlusion although 100% re-established (some being partial). What is defined as only partial re-establishment of occlusion isn’t clear.</td>
</tr>
<tr>
<td>Anderson [9] 1962</td>
<td>Hospital setting, small sample size of 5 patients, mean time to re-establish occlusion not given, measurements were of distances between reference point on opposing teeth, no measurements of tooth contacts were taken only subjective reports of when the patients could bring teeth into contact, approximation of increase in OVD given only with no case specific data.</td>
</tr>
<tr>
<td>Dahl and Krogstad [8] 1982</td>
<td>Hospital setting, no mean time on re-establishing occlusion given, no case specific data on increase in OVD, all patients had gross tooth wear, mainly anterior, radiographic assessment of implants until they showed no or hardly any distance between them, no assessment of tooth contacts, wide range in increase in OVD, 6 patients had restorations placed before stabilisation of distance between implants and occlusion re-established according to papers definition because of patients anxiousness to have restorations made.</td>
</tr>
</tbody>
</table>

### 3.4. Time for occlusion to re-establish

The time taken for the occlusion to re-establish ranged from 15 days to 24 months. Not all the studies recorded both the full range of and mean time that it took for the occlusion to re-establish. The mean time taken was not given for four studies [8,9,12,26] whilst Gough and Setchell [13] provided a median time taken and no mean. The full range of times taken was given for all studies except for the Harley and Ibbetson paper, which stated that occlusion re-established in all patients within a maximum period of 3 months [26].

The two studies with the youngest patient groups for which the age range across the two studies was 5-18, reported the shortest times for the occlusion to re-establish, with maximum time periods of both 3 months and 30 days [12,26].

Apart from those studies, which calculated the mean time taken, none of the studies carried out statistical analysis specifically related to the time taken for occlusion to re-establish, except for Zee and Amerongen [1].
4. Discussion

This qualitative systematic review set out to address four main questions related to the re-establishment of occlusion following the placement of dental restorations at an increased occlusal vertical dimension. Namely, how predictable the process is, how long the process takes, what predictable variables are there and what is the quality of the evidence that is available. In the absence of randomised controlled trials, this review looked at the best available evidence, primarily prospective and retrospective cohort studies.

Across all the included studies the expected re-establishment of occlusion occurred in most cases and appears predictable. Where occlusal contacts did not re-establish there were some clear explanations as to why, such as poor patient compliance in wearing an appliance. In selected instances, there was not an obvious reason for failure of occlusal re-establishment. Some have speculated that in some cases there may be a lack of eruptive potential [11,25]. A study by Craddock et al. [15] suggested that there is a limit to the amount of supra-eruption, as they termed it, that can occur and that between 27% and 32% of unopposed posterior teeth had over-eruption of more than 2mm. Out of the 169 patients that were included across the 9 studies, 4 showed no apparent tooth movement with no clear explanation. It is suggested that previous tooth wear, dento-alveolar compensation and lack of eruptive potential could be an explanation for this. In cases where there is an apparent lack of eruptive potential and none, or insufficient, inter-occlusal space is achieved, then a more conventional approach of restoring the occlusal surfaces could be taken.

What was deemed to be re-establishment of occlusion, or success, was not consistent between all studies, nor was the method or assessing it. This makes drawing specific conclusions from all studies challenging, however, it does seem apparent that within the patient demographic covered in these studies, the process is predictable. There are several ways occlusion could be considered to have re-established and this is demonstrated across the included studies. It could be defined clinically as the return of occlusal contacts on some or all the teeth. How this is assessed can also vary: Methods include the use of Shimstock foil or study models, for example.

There appears to be a wide range in the reported time this process takes. Different follow up periods and review intervals in the included studies mean that there was inevitably a difference in findings. Not all the studies reported both the full range of time and the mean time it took for the re-establishment of occlusion. Individual data for the time the process took in each patients’ case was scarcely available: This would be useful data for assessment and any possible meta-analyses.

There was no study identified that specifically set out to investigate the amount of time that it would take for the occlusion to re-establish after restoring at an increased OVD. Rather, they generally focused on the clinical performance of restorations at an increased OVD, and thus statistical analysis, apart from a simple mean calculation, was not related to the time the process takes. The one exception is Zee and Amerongen [12], who applied a nonparametric, Wilcoxon Signed Ranks, test (P=0.05). One further consequence of the primary aims of the included studies not being to study the time taken for the re-establishment of occlusion, is that variables, which may or may not relate to both the predictability of the process and the time it takes were not always reported on. There was certainly no statistical analysis of variables such as patient age, tooth position or increase in OVD relating to the success or time taken. Having said that, the two studies which looked at the youngest patients reported the shortest times for the occlusion to re-establish [12,26]. In addition, three studies noted that the pre-molar region took the longest to re-establish occlusal contacts, but again no statistical analysis for this was carried out [11,17,18].

Measuring the time the process takes in relation to specific variables such as the amount of increase in OVD, is difficult to measure accurately in a clinical situation. For instance, the amount an articulator pin is opened on study models cannot be directly related to the separation this creates between the teeth. Nevertheless, how the increase is recorded is relevant for understanding of the methodology and for reproducibility. Recording the amount of increase in OVD would also be ideal for the same reasons. Having said this, it may be simpler to only consider the increase in OVD in a binary sense where the increase is either such that the other teeth cannot be brought into occlusal contact or that they can. A very small increase is just a ‘high filling’ and not the same as an increase in OVD. An increase in OVD should result in the other teeth not being able to be brought into occlusal contact.

Overall it would appear within the limitations of the included studies, that the re-establishment of occlusion is much more predictable in younger patients. Of course, the ongoing growth in younger patients’ may increase speed and/or likelihood of new occlusal contacts developing. It would also seem logical that when there is an increase in the OVD that prevents other teeth coming into contact, a smaller increase in the OVD would result in occlusal contacts re-establishing faster than where there has been a large increase in OVD, although none of the included studies shed any light on this. It could be assumed that the occlusion would re-establish predictably where a small increase in the OVD in a young patient is carried out as this would require less tooth movement in a patient who may have more potential for growth, but this isn’t speculated in any of the studies.

Non-carious tooth tissues loss was the primary aetiology in six of the eight studies which specified an aetiology. This is unsurprising because of the clinical problem it presents and the frequent occurrence of the lack of space for a restoration observed in this group. These patients have already demonstrated a tendency for alveolar compensation because they have lost the space required for restoration, which is why the treatment is necessary. Although this may be an indication of the predictability and outcome of occlusal re-establishment in this group of patients, the amount and quality of the evidence available for treating other groups in this manner is very poor. It adds an element of selection bias and reduces the external validity of each study in applying the results to the general population or other treatments where this process may be utilised; for example, it is not clear whether the results would be similar in a group of patients treated with adhesive bridgework (RBRs) cemented high in occlusion and makes comparison between studies or collation of data more challenging. The number of patients involved within each study was variable, but no power calculations were carried out to indicate how this affected the strength of the evidence.

A consistent definition of re-establishment of occlusion is needed in terms of number of teeth and extent to which teeth contact. In addition, a reliable method of assessing this has not been clearly identified. The various ways of doing this used in the current system-
atic review studies present their own problems. Any biological cost to the patient such as irreversibly marking teeth would be unethical as would any unnecessary radiographic assessment. Adhesive markers such as composite could be considered, but again these may then act as plaque retention factors and as such could be deemed unethical. Checking holds between occlusal contacts using Shimstock foil, as used in some of the included studies, may be a more reliable and reproducible method.

Ideally, wear of the restorations placed at an increased OVD should be taken into consideration. Additionally, it would be useful to have a clear indication of how much the reestablishment of occlusion and the movement of teeth is associated with extrusion / intrusion of teeth, dentoalveolar compensation, or if any unwanted lateral movements of teeth or mandibular movement / autorotation is occurring, allowing for occlusal contacts to occur for reasons other than tooth movement, which is not the aim of the investigation. However, this can be very difficult to assess.

Comparing results between studies was challenging because of the significantly differing methodologies and lack of individual data available for all the studies. This systematic review identified several weaknesses in the available clinical studies, some of which are relatively easy to overcome but others, such as controlling the confounding factors, would be extremely difficult to achieve in any clinical trial.

Recommendations for future study include investigation of the effect of confounding factors such as patient age, tooth position, number of teeth, aetiology, amount of increase in OVD, height of restoration, aetiology (including hypodontia), occlusion and previous orthodontic treatment on the predictability and time taken for occlusal contacts to re-establish following restoration at increased vertical dimension. Additionally, whether similar effects are predictable for different restoration types, such as adhesive bridgework.

5. Conclusion

The re-establishment of the occlusion following restoration at an increased OVD appears to be predictable in most cases, but the quality and quantity of the available evidence is lacking. The time taken for the occlusion to re-establish was between 15 days to 24 months. However, there is a need for prospective studies to evaluate the process in terms of success, predictive variables and specifically how long the process takes and this information would be helpful for both clinicians and patients, so that they know what to expect before embarking on a treatment.

Other information

The authors declare that they have no conflicts of interest. And no funding was required for the review. Data collection forms, data extracted from included studies and data used for all analyses can be provided by the authors on request.

References


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