

Impression Techniques for Distal Extension Cast Removable Dental Prosthesis (DE CRDPs): A Systematic Review

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Abstract

Purpose: The purpose of this study was to systematically review the available literature and determine the best possible impression technique for the fabrication of distal extension Cast Removable Dental Prosthesis (DE CRDPs).

Material and method : The indexed English literature published from 1960 to 2020, was systematically searched for various impression techniques for the fabrication of distal extension CRDPs using guidelines recommended by Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) and the participant, intervention, control, outcomes (PICO) principle. The

databases searched were MEDLINE (PubMed), Google Scholar & EBSCO. The relevant studies screened and shortlisted based on predefined inclusion and exclusion criteria. In vivo and English language studies evaluating the best possible impression technique for the fabrication of distal extension CRDPs were included in this systematic review.

Results: Nine studies were included in this review. All nine studies reported that CRDPs fabricated with altered cast impression technique displayed less vertical movement of denture bases compared to those fabricated using other impression techniques.

Conclusion: The results of this literature review indicate that the altered cast impression technique offers significant advantages over other impression techniques which provides the least amount of vertical denture base movement, less stress concentration on the abutment teeth with good patient satisfaction compared to other techniques in distal extension CRDPs.

Keywords : DE CRDPs - Distal extension cast removable dental prostheses , Impression techniques for distal extension CRDPs, ACIT - Altered cast impression technique, Single-impression technique, One-piece cast impression technique.

Introduction

Removable dental prostheses (RDPs) contribute significantly as a treatment option for patients aged above 65 years¹ in developed countries. Fabrication of RDPs is more complex in distal extension (DE) edentulous ridges because of differences in the degree of displaceability of the overlying mucosa and abutment teeth.^{2,3} Impression-making is a vital step in the fabrication of any prosthesis. An impression should satisfy DeVan's dictum, which states: "Perpetual preservation of what remains is more important than the meticulous replacement of what is missing."⁴ Impression-making for cast removable dental prostheses (CRDPs) should record the soft tissues without distortion.⁵ The primary aim while making an impression is to achieve optimal denture support and extension.⁶⁻⁸ This in turn assures denture stability and effective function. Multiple theories and techniques of impression-making using different materials are present in the literature.⁹⁻¹³ Despite wide variation in individual preferences, the most acceptable approach is to record the teeth in anatomical form and the mucosa overlying the ridge in functional form.^{2,3,14}

The altered cast impression technique (ACIT), suggested by Applegate,⁸ is one of the most acceptable and widely used techniques. Studies by Holmes,² Vahidi,¹⁵ and Leupold³ have demonstrated that the principles of controlled tissue support were best fulfilled by the ACIT. Conventional impression techniques using single-step impressions and one-piece casts are generally not advocated for DE CRDPs because of numerous debatable reasons, but various surveys^{16,17} show that ACIT is not very commonly used in clinical practice. This has been attributed to the risk of potential technical errors, expenses, added time, and perceived lack of benefit. This study aimed to systematically review the available literature and determine the best possible impression technique for the fabrication of distal extension CRDPs.

Material and method

The indexed English literature published from 1960 to 2020, was systematically searched for various impression techniques for the fabrication of distal extension CRDPs using guidelines recommended by Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) and the participant, intervention, control, outcomes (PICO) principle. The databases searched were MEDLINE (PubMed), Google Scholar & EBSCO. The relevant studies screened and shortlisted based on predefined inclusion and exclusion criteria. In vivo, English language studies evaluating the best possible impression technique for the fabrication of distal extension CRDPs in this systematic review.

Inclusion criteria

- Literature in English language
- Studies on distal extension removable dental prostheses
- Human clinical studies
- In vivo studies

- Comparison between impression techniques
- Comparison between impression materials
- Studies highlighting clinical outcomes and theoretical concepts

Exclusion criteria

- Animal studies
- Literature in language other than English
- Studies on tooth supported removable dental prostheses
- Letters to the editor, unpublished abstracts, reports, commentaries
- Implant and maxillofacial prostheses

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the participant, intervention, control, outcomes (PICO) principle, A research question was framed as follows:

- Participants: Patients who underwent replacement of teeth in DE edentulous ridge with CRDPs.
- Intervention: ACIT or Other impression technique in fabrication of DE CRDPs.
- Comparison: Fabrication of DE CRDPs using ACIT and Other impression technique.
- Outcome: Vertical displacement of soft tissues, load on the direct abutment & periodontal changes in abutment teeth and patient satisfaction with and without ACIT or impression techniques.

Quality analysis

The Critical Appraisal Skills Program (CASP) Cohort Study Checklist was used for the quality analysis of the studies included in this review. Ten questions based on the CASP Checklist were designed to analyze the articles systematically. Each question could be answered as “yes” “no” or “can not tell” The total score from each study was calculated.

The questions used were:

1. Did the study address a clearly focused issue?
2. Was the cohort recruited in an acceptable way?
3. Was the exposure accurately measured?
4. Was the outcome accurately measured?
5. Were all important confounding factors identified?
6. Are the results precise?
7. Are the results reliable?
8. Can the results be applied to the local population?
9. Do the results of this study fit with other available evidence?
10. Are there any significant clinical implications?

Results

The initial electronic search yielded 420 titles. After removing duplicates, 304 remained. Of these, 269 records were excluded by screening for titles and abstracts. Than 26 records were excluded because they are irrelevant to search objectives. Among which 2 records excluded because they were surveys, 7 were excluded because they compared impression techniques other than the ones being studied, 17 records excluded because mentioning impression technique without comparison. 9 studies were included in the systematic review. (Figure 1)

The included articles were published between 1960 and 2020. All of the articles were in English, and all the 9 eligible studies were in vivo studies investigating best possible impression technique for the fabrication of distal extension CRPDs.^{2,3,14-20} (Table 1)

The minimum number of specimens per group was 1^{2,14} and the maximum number of specimen per group was 72.¹⁶ Six different impression techniques were used to investigate the best possible impression technique for the fabrication of distal extension CRPDs , among which altered cast impression technique was most commonly used (9 studies)^{15,16}, followed by, stock tray (2 studies),

single tray (2 studies) and functional impression technique (1 study). (Table 1)
 (2 studies), followed by anatomic and Hindels impression

Figure 1: Article selection strategy based on PRISMA guidelines.

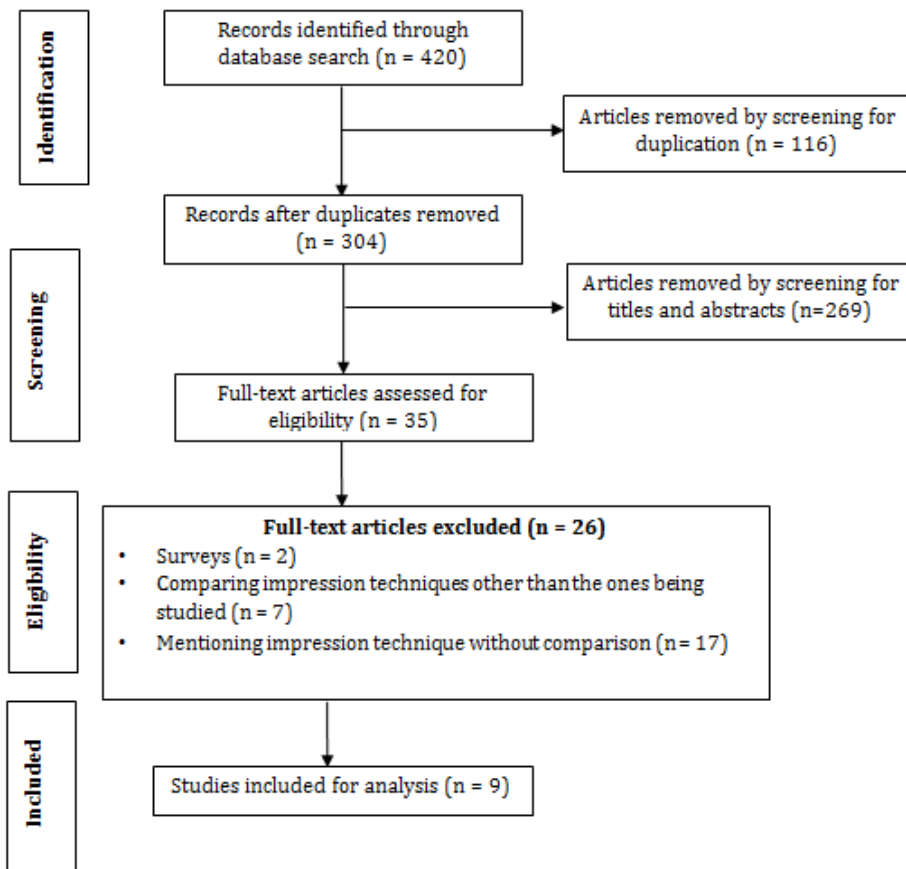


Table 1 : Studies Based on Impression Technique and Vertical Displacement of Soft Tissues.

Sn.	Author	Study type	Sample size	Study group	Outcome
1	Madihalli et al (2011)	In vivo	1	Compared tissue placement with different impression procedures in bilateral DE RDPs: Group 1: Hindels method Group 2: Selective pressure technique with altered cast Group 3: Functional relined altered cast	Maximum tissue placement was observed in Group 2 (7.547), followed by Group 1 (7.2110), and the least placement was in Group 3 (5.856). Group 2 produced the best controlled tissue support.
2	Hikmat et al (2009)	In Vivo	20	Group 1 : 10 patients receiving partial dentures constructed from a conventional impression	Group 2 : Altered cast impression technique for distally extended RPD will

				<p>technique.</p> <p>Group 2 : 10 patients receiving partial dentures constructed from an altered cast impression technique.</p>	<p>result in a less stress concentration on the abutment teeth as compared with Group 1 resulting in proper periodontal health and reducing damage of periodontal tissues.</p>
3	Frank et al (2004)	In vivo	72	<p>DE RPD fabricated on:</p> <p>Group 1: Altered cast</p> <p>Group 2: One-piece cast</p>	<p>Group 1 showed 0.15 mm less space between ridge crest and base compared to Group 2; the difference was statistically Significant, but not clinically significant.</p>
4	El-Sheikh et al (1998)	In vivo	5	<p>Compared vertical movement of DE RPD bases:</p> <p>Group 1: Processed on master casts made from full-arch final impressions using custom rays</p> <p>Group 2: Re-adapted on altered cast made from sectional relining impression. There was a statistically significant</p>	<p>There was a statistically significant difference between the vertical movements of denture bases in Group 1 (0.38 mm) and Group 2 (0.32 mm). The mean difference between Group 1 and Group 2 was measured to be 0.06 mm; this difference was clinically insignificant.</p>
5	Leupold et al (1992)	In vivo	7	<p>DE RDPs made from:</p> <p>Group 1: Altered cast technique (using light bodied polysulfide rubber)</p> <p>Group 2: Border-molded custom tray (using light-bodied polysulfide rubber)</p> <p>Group 3: Stock tray using irreversible hydrocolloid impression material (control)</p>	<p>There was a statistically significant difference between the vertical movements of denture bases in Group 1 (0.60 mm) and Group 2 (0.79mm). The mean difference between Group 1 and Group 2 was measured to</p>

					be 0.19 mm; this difference may or may not be clinically relevant.
6	Maxfield et al (1979)	In vivo	2	CRPDs fabricated using: Group 1: Anatomical impression Group 2: Altered cast technique	In broad residual ridges with dense relatively immovable soft tissue, there was minimal tissue displacement for Groups 1 and 2. In moderately resorbed residual ridges covered with relatively mobile soft tissue, there was more tissue displacement in Group 1 compared to Group 2.
7	Vahidi et al (1978)	In vivo	10	Group 1: Functional impression technique using No. 4 Korecta wax along with altered cast Group 2: Single-impression technique using mercaptan rubber base impression Group 3: Mucostatic impression using irreversible hydrocolloid impression material (control)	Group 1 presented greatest vertical displacement of tissues (1.170, 0.960, and 0.885 mm), followed by Group 2 (0.345, 0.315, and 0.340 mm); the difference was statistically significant.
8	Leupold et al (1966)	In vivo	5	Group 1: Use of a single mix of impression material to make an impression and a one-piece cast to fabricate the prosthesis. Group 2: Use of a two-section impression and either a one or a two-section cast to fabricate the prosthesis.	By comparison with the Group 2: altered cast procedure, Group 1: Stock tray impressions distorted the loose mucosal tissues in edentulous regions in a horizontal as well as in a vertical direction. Although the horizontal distortion was not nearly so great as the vertical distortion.

9	Holmes et al (1965)	In vivo	1	DE RPD–fabricated from impressions made using: Group 1: Stock rim lock tray using irreversible hydrocolloid Group 2: Individual resin tray using irreversible hydrocolloid Group 3: Altered cast technique using different impression materials (a: Korecta wax; b: irreversible hydrocolloid; c: metallic paste; and d: rubber injection)	Minimum movement was exhibited by Group 3d. Group 1 exhibited maximum movement. Almost similar movements were observed in Groups 3c and 3b. The differences were statistically significant.
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Vertical Displacement of Soft Tissues relative to Impression Technique

Vahidi²⁰ (1978) compared tissue displacement for DE ridges using the functional impression technique and single-impression technique, keeping the mucostatic impression technique as a control. Ten patients with mandibular DE ridges were selected, and impressions using each of the three techniques were made for each patient. Impression techniques used in this study were: functional impression technique using No. 4 Korecta wax along with altered cast; single-impression technique using mercaptan rubber base impression; and mucostatic impression using irreversible hydrocolloid impression material. The vertical displacement of tissues, with each impression technique, was measured at three specific points on the crest of the ridge. These points were approximately at the center of the retro molar pad, 5 mm posterior to the last tooth, and midway between the two previous points. The results of this study showed that there was a statistically significant difference in vertical displacement of tissues made by the different impression techniques. The vertical displacement of tissues was greatest with the functional impression technique (1.170,

0.960, and 0.885 mm), followed by single-impression technique (0.345, 0.315, 0.34 mm), with mucostatic impression technique causing minimum tissue displacement.

Leupold³ (1966) studied the differences in the amount of tissue displacement and adaptation of denture bases between removable partial dentures constructed on one-piece casts and those made on altered casts. He said that since tissue contours over the crest of the edentulous ridge and in adjacent regions of attached gingivae were identical in both methods of soft tissue registration, any differences in support that might affect denture stability must lie in the regions of loose unattached alveolar mucosa on the lateral aspects of the ridge and in the vestibular sulci. By comparison with the altered cast procedure, the stock tray impressions distorted the loose mucosal tissues in edentulous regions in a horizontal as well as in a vertical direction. Although the horizontal distortion was not nearly so great as the vertical distortion, it could have a marked effect on support of the finished denture in the edentulous regions when combined with other factors, such as the distortion of the hydrocolloid impression materials and the curing shrinkage of acrylic resin. The

distortion of tissues by the stock tray impression was greatest where support is needed most (in the retro molar areas). This limited study of adaptation indicates that a more favorable support relationship for mandibular distal extension removable partial dentures was attained by the altered-cast procedure than by the stock tray impression and one-piece cast technique.

Leupold et al¹⁸ (1992) performed an in vivo study and compared the vertical displacement of DE RDPs. Dentures were made from ACIT (using light-bodied polysulfide rubber), an impression made from a border-molded custom tray (using light-bodied polysulfide rubber), and a stock tray using irreversible hydrocolloid impression (serving as control). An intraoral loading device was used to measure the vertical displacement of DE RDPs. The distance between the posterior abutment and the point where load was applied was standardized. The results of this study indicated that, under simulated intraoral loading, the technique of the impression-making influenced the vertical displacement of the denture bases. There was a statistically significant difference between the vertical movement of denture bases made from ACIT (0.60 mm) and border-molded custom tray impression (0.79 mm). The mean difference between the two techniques was 0.19 mm. The study concluded that the ACIT provided controlled tissue support that resulted in the least amount of denture base vertical movement. However, it is questionable whether this minimal difference in movement is clinically relevant.

Holmes et al² (1965) used different impression techniques to fabricate DE RDPs in a clinical study. The amount of movement resulting from occlusal loading of these dentures was measured. Impression materials and techniques used were: irreversible hydrocolloid in stock rim lock tray; irreversible hydrocolloid in individual resin

tray; and different impression materials (Korecta wax, irreversible hydrocolloid, metallic paste, and rubber injection) with ACIT. The results show that dentures fabricated by ACIT (using Korecta wax IV) exhibited minimum movement. Maximum movement resulted in dentures fabricated using stock rim lock tray with irreversible hydrocolloid impression material. Almost similar movements were exhibited by dentures fabricated using metallic oxide paste and rubber injection material.

Frank et al¹⁶ (2004) performed a clinical study that compared the effectiveness of altered and one-piece casts. The study showed that there was a statistically significant difference of 0.15 mm in adaptation of the base to the ridge crest. However, clinical detection of this difference in rotational movement of the denture bases is extremely difficult. Therefore, this difference is clinically insignificant. At the 1-year follow-up, there was minimal difference in the adaptation of the base to the alveolar ridge as compared to baseline.

Madihalli et al¹⁴ (2011) performed a clinical study and compared the tissue placement with different impression procedures in bilateral DE RDPs. The study compared: Hindel's method; selective pressure technique with altered cast; and functional reline with altered cast. Maximum placement was achieved with the selective tissue placement method using ACIT, and this method produced controlled tissue support.

El-Sheikh et al¹⁷ (1998) compared the vertical movement of mandibular DE RDPs under biting force. Master casts made from the full-arch impressions (using custom tray) were used to fabricate denture bases for five patients with mandibular DE ridges. Later, these bases were readapted on an altered cast made from the sectional relining impression. The impression material used was regular body polysulfide. Interocclusal records were made with

plaster, with the denture at rest and under biting pressure. The thickness of these plaster interocclusal records was measured to compare the vertical movement of the denture bases. The mean vertical denture base displacement was 0.32 mm for the sectional impression, while it was 0.38 mm for the conventional full-arch final impression. With sectional impressions, the vertical movement of the denture bases decreased. This difference of 0.06 mm was statistically significant but clinically insignificant. It was concluded that the final impression made in a border-molded full-arch custom tray was enough to provide support to DE RDPs.

Maxfield et al¹⁹ (1979) did a clinical study on two patients and compared the magnitude of forces applied on the abutment tooth during mastication by CRDPs fabricated using anatomical impressions and ACIT. The study found that in broad residual ridges covered with dense immovable soft tissues, tissue displacement was minimal, and base adaptation of CRDPs was comparable. However, when moderately resorbed residual ridges were covered with relatively mobile soft tissue, tissue displacement was greater for the prosthesis fabricated on the anatomical cast compared to the altered cast.

Hikmat et al¹⁵ (2009) in his study compared the periodontal status in patients receiving partial dentures constructed from conventional and altered cast impression techniques. He selected twenty patients receiving mandibular bilateral distal extension removable partial denture for treatment, the patients divided into ten patients receiving partial dentures constructed from conventional impression technique and other ten patients receiving partial dentures constructed from an altered cast impression technique. The periodontium of the last abutments had been evaluated using gingival bleeding index and probing pocket depth, the first score have been

made at time of insertion, the second score made after 3days of insertion, the third score after 10days of insertion, the fourth score after 30 days of insertion, the fifth score after 45 days of insertion and the last score was made after 60 days of insertion. Student t-test had been made to evaluate the periodontal conditions at different time intervals. The results revealed that there would be a decrease in both periodontal indexes scores with time. He concluded that the use of altered cast impression technique for distally extended removable partial dentures will result in a less stress concentration on the abutment teeth resulting in a proper periodontal health and reducing damage of periodontal tissues this will be in addition to proper oral hygiene being established.

Load on the Direct Abutment relative to Impression Technique

Frank et al¹⁶ compared the effectiveness of altered and one-piece casts and found that there was no detrimental effect on abutment teeth with either technique. The study concluded that there were no changes in mobility, sulcus depth, or Gingival Index.

Maxfield et al¹⁹ did a clinical study on two patients and compared the magnitude of forces applied on the abutment teeth during mastication by CRDPs fabricated using anatomical impression and altered cast technique. When using mesial occlusal rest, the mean force on the abutment teeth in anatomical cast was 2.888 and 2.750 kg, while in the altered cast it was 2.171 and 1.025 kg. It was concluded that abutment teeth are subjected to the lowest forces when dentures are fabricated using ACIT.

Hikmat et al¹⁵ (2009) in his study compared the periodontal status in patients receiving partial dentures constructed from conventional and altered cast impression techniques. He Concluded that the use of altered cast impression technique for distally extended removable

partial dentures will result in a less stress concentration on the abutment teeth resulting in a proper periodontal health and reducing damage of periodontal tissues this will be in addition to proper oral hygiene being established.

Patient Satisfaction relative to Impression Technique :

Only one study by Frank et al¹⁶ compared the patient satisfaction or frequency of soreness related to the impression technique. The study was conducted in a clinical setting to compare the effectiveness of altered and one-piece casts and found that there was no disparity in patient satisfaction or frequency of soreness. A similar number of base adjustments were observed.

Discussion

This review aimed to systematically review the available literature and to determine best possible impression technique for distal extension CRDPs.

First of all, the effect of impression techniques on vertical displacement of tissues was reviewed. All included studies were in vivo studies. A common consensus can be drawn that the DE CRDPs fabricated by ACIT displayed less vertical movement of the denture base compared to those fabricated using other impression techniques. (Table 2)

Two of these studies reported that this difference in vertical movement was clinically insignificant, while the other seven studies reported a statistically significant difference in vertical movement, but were uncertain relative to its clinical significance. The type of residual ridges and the nature of supporting soft tissues play important roles in the vertical displacement of soft tissues. In broad residual ridges with dense, relatively immovable soft tissue, there was minimal tissue displacement for DE CRDPs fabricated with ACIT and single-impression techniques; whereas in moderately resorbed residual ridges covered with relatively mobile soft tissue, tissue displacement was greater for DE CRDPs fabricated with

anatomical impression. The proximity of the edentulous ridge to abutment teeth played a role in changing the vertical displacement of soft tissues. Furthermore, the soft tissue covering the crest of the ridge became more displaced as the point of application moved posteriorly from the last abutment tooth. The amount of tissue displacement increased from the last abutment to the retromolar pad on the crest of the ridge.^{2,3,14-20}

Secondly, the patient satisfaction and frequency of soreness were similar for DE CRDPs fabricated on altered and one-piece casts, as the same number of base adjustments were observed. Further, there was a difference in opinion relative to measuring the direct load on the abutment when DE CRDPs were fabricated using altered and one-piece casts.^{15,16,19} Maxfield et al¹⁹ (1979) suggested that the altered cast produced the least force on abutments whereas Frank et al¹⁶ (2004) found that there were no detrimental effects on abutment teeth with either technique and there were no changes in mobility, sulcus depth or Gingival Index.

Hikmat¹⁵ (2009) found that the altered cast impression technique provides the least movement of extension bases under an occlusal load when compared with bases processed from a conventional cast. So there was a decrease in both periodontal indexes scores from time of insertion till the last visit of follow up. This decrease in periodontal scores may be attributed to the advantages of the altered cast impression technique in providing stability to the extension base and increase support for the base that resulted in a decrease forces on the abutment tooth in addition to mesial rests that had been used in cases examined in his investigation. This mesial rest transferring the chewing force more perpendicular to ridges than the distal occlusal rests, hence the gingival mucosa of the abutment tooth was better protected, this means the

gingival tissues gives better response to the applied load, this will lead to decrease in amount of inflammation in gingival tissues with time.

Thus all these studies have claimed the superiority of ACIT to other impression techniques, which gives strong scientific support for older theories recommending the use of ACIT as the preferred impression technique for fabricating CRDPs for DE situations.

Conclusion

Within the limitations of this systematic review, the following may be concluded

1. The altered-cast impression technique provided the least amount of vertical denture base movement in DE CRDPs.
2. Horizontal distortion was not nearly so great as the vertical distortion in comparison of different impression techniques in DE CRDPs.
3. The altered cast impression technique for DE CRDPs will result in a less stress concentration on the abutment teeth with good patient satisfaction compared to other techniques.
4. Selective pressure impression technique is best to produce altered cast for DE CRDPs.

The results of this literature review indicate that the altered cast impression technique offers significant advantages over other impression techniques for DE CRDPs.

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