Subject Area: Restorative Dentistry

Direct versus indirect pick up of the locator retentive caps for two implant supported mandibular over denture: (a cross over study)

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ORIGINAL ARTICLE

Direct Versus Indirect Pickup of the Locator Retentive Caps for Two-implant-supported Mandibular Overdentures: A Crossover Study


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Abstract

Aim: This study aimed to compare and calibrate the clinical retention of direct versus indirect pickup of locator attachment retentive caps used to retain mandibular overdentures connected to two implants installed in the canine regions.

Patients and methods: Ten patients received two implants in the canine areas of the mandible. According to the pickup technique of retentive caps and the color of the retentive inserts of locator attachments, the mandibular overdentures were classified into four groups as follows: group I: overdentures with locator retentive caps and blue inserts were picked up by the indirect method. Group II: overdentures with locator retentive caps and pink inserts were picked up by the indirect method. Group III: overdentures with locator retentive caps and blue inserts were picked up by the direct method. Group IV: overdentures with locator retentive caps and pink inserts were picked up by the direct method.

Results: Calibration of the manufacturer retention values using a force meter device mounted to a holder device revealed up to 91.25–95 % accuracy of the retentive values measured in this study. A statistically significant difference in retentive scores was found between all inserts picked up directly or indirectly as verified by the Kruskal–Wallis test except between group II and group IV (P = 0.061) and between group I and group III (P = 0.061) where no statistically significant difference in retention was found.

Conclusion: Laboratory (indirect) pickup assembly of the locator attachments could be considered the technique of choice to avoid difficulties of the direct pickup procedures.

Keywords: Clinical retention, Implant overdenture, Locator attachment, Pickup techniques

Introduction

Complete tooth loss is regarded as a negative health outcome that could affect the quality of life. Complete removable maxillary and mandibular dentures, which are the conventional course of therapy for edentulous patients, have many drawbacks, particularly with the lower denture, including inadequate retention and stability, poor chewing efficiency, and discomfort during mastication.

For edentulous mandibles, an implant-assisted overdenture has now become the treatment of choice. A two-implant-assisted mandibular overdenture should be the standard treatment option for edentulous people.

When an overdenture is retained by two anteriorly placed implants, the major support of the overdenture is derived from the residual ridge tissue. The overdenture occurs around a fulcrum passing through the two implants and leads to posterior tissue changes, loss of fit, and adaptation between the overdenture and the ridge tissue.

In addition, the tissue health around the implant is subjected to high risk, especially if the implant is rigidly connected to the overdenture base. The
longer the lever arm of the distal part, the greater the rotational force and the more the damage to the residual ridge around the implants. Movement between the denture and the implant is allowed by using a flexible connection between the implants and the overdenture. The mucosal resilience is compromised to achieve this movement, which allows the alveolar ridge to absorb the majority of stresses. Consequently, the mucosal support’s resilience must be consistent with the connection’s resilience between the implant and the denture base.

Locator attachment is a unique resilient attachment design that allows a rotational movement that matches the resiliency of the supporting mucosa without unfavorable harmful stresses on the residual ridge and the implant. The resiliency of the attachment needed to preserve the residual ridge is greatly affected by the final impression technique and the technique of assembling the attachment components.

There are two techniques to assemble the locator attachment components, namely direct techniques (functional pickup of the retentive caps performed by the clinician intraorally) and indirect techniques (the attachment assembly done on the cast by the technician in the laboratory). Although the functional pickup technique relates the attachment component to the functional form of the ridge to reduce the harmful rotation of the denture base during function, it has clinical difficulties in controlling the pickup resin material in relation to the locator abutment and direct visibility of the excess resin during the patient closing in centric occlusion. However, these difficulties could be avoided in the laboratory pickup procedures when a final functional impression is recorded for the master cast construction.

The retention values measured in most research were not related to that of the manufacturer’s retentive values. Consequently, there was no obvious evidence for the accuracy of their measured values. The purpose of this study was to evaluate the effect of direct and indirect pickup of the locator retentive caps on overdenture retention immediately and after different periods of overdenture insertion and to compare the study measurement of the retention force with those of the manufacture retentive force.

The null hypothesis of the study posited that there would be no significant difference between both pickup techniques and between the study measurements of the retention force and those measured by the manufacturer.

Patients and methods

Ten patients from the outpatient clinic at the Prosthodontics Department, Faculty of Dentistry, Mansoura University, with ages ranging from 45 to 64 years (mean 56 years), were chosen for this study. An 80% power was calculated for this patient group based on the findings of an earlier investigation, which demonstrated that there was no statistically significant difference in retentive values for two implant-supported overdentures using two unsplinted attachment systems (effect size = 0.70 and 0.05 mm). The G*Power software (version 3.1.5, Kiel, Germany) was used to do the power analysis. Patients who met the following inclusion criteria participated in the study: (a) preoperative cone beam computer tomography confirming adequate bone amount [class III–V according to Cawood and Howell in the interforaminal area of the jaw to accommodate two implants (4.1 × 13 mm)], (b) adequate restorative space for a locator-supported implant overdenture (12–15 mm from the mandibular ridge mucosa to the occlusal plane, class I according to Ahuja and Cagna). This was confirmed by measuring the space under the old dentures directly. Class I maxillo-mandibular connection in Angel classification. Systemic conditions that preclude implant placement, bone metabolic conditions such as diabetes mellitus, radiation to the head and neck region, or chemotherapy within the last 3 years are among the exclusion criteria. Throughout the study, patients were informed of the treatment plan and the requirement for repeated callbacks. They all also signed contracts in writing. This study was performed in line with the principles of the Declaration of Helsinki and by CONSORT recommendations as shown in Fig. 1. It was approved by the local ethics committee of the faculty (No. A17030821) and was registered on the clinical trial website under the number (No. NCT05289752). All patients expressed interest in participating in the treatment protocol offered in the study. They were thoroughly informed about the full details of surgical procedures and recall appointments. They signed a written consent before beginning the study.

In this crossover study, the patient overdentures with two successive different pickup techniques for the locator retentive caps, each technique was evaluated for the retention force with blue and pink retentive inserts. After each pickup technique, the overdenture was evaluated for the clinical retentive force immediately, and at 3 and 6 months. According to this arrangement, the retentive force data was collected and grouped as follows: group I: 10
overdentures with locator retentive caps, and blue inserts were picked up by the indirect method, group II: 10 overdentures with locator retentive caps and pink inserts were picked up by the indirect method, group III: 10 overdentures with locator retentive caps and blue inserts were picked up by the direct method, group IV: 10 overdentures with locator retentive caps and pink inserts were picked up by the direct method.

Every case required cone-beam computed tomography (CBCT) to measure the height and width of the mandibular canine bones. All patients in both study groups received conventional mandibular full dentures. To create a radiographic template, the mandibular dentures were duplicated in clear acrylic resin. To install reference gutta-percha radiopaque markers, several holes (1 mm in diameter) fitting the surface of the mandibular radiography template were made in various labial, buccal, and lingual polished surfaces. Patients were subjected to CBCT while wearing the radiographic template. Then the radiographic template was subjected to CBCT exposure alone. The individual images were superimposed over each other using a dual-scan technique guided by gutta-percha radiopaque markers to estimate mucosal thickness. The implant planning was used to construct a mucosal-borne stereolithographic guide using the laser sintering technology (In2Guide).

Chlorhexidine digluconate 0.2 % mouthwash and antibiotic (amoxicillin and clavulanic acid) was started 1 day before surgery and then twice/daily for 1 week following surgery. The same oral and maxillofacial surgeon placed two (4.1 × 13 mm, RES, IMAX, tapered internal, Switzerland) implants using the flapless surgical technique. The stereolithographic stent was attached to the mandibular mucosa using a rubber base interocclusal record, and the stent was attached to the mandibular bone using fixation pins. An all-purpose surgical kit (In2Guide) was used to prepare implant osteotomies. For sufficient primary stability, the implant insertion torque must have been at least 35 Ncm.

The mandibular denture was relieved above the implants and relined with a chairside silicone-based soft liner to act as a cushion. For both groups, the implants were covered with the cover screw, after 3 months, the cover screw was unscrewed, and the healing abutments were inserted for 1 week for gingival recontouring. The locator abutment was placed using a hex driver and hand tightened. The female housing caps with the black nylon inserts were positioned over the locator abutment for the direct pickup technique. The chosen final retention inserts, blue for light retention for the first 6 months and pink for medium retention for the next 6 months were used to replace the zero-retention black nylon inserts (Fig. 2). Occlusion was then
refined by selective grinding. All patients were instructed to perform oral hygiene measures such as cleaning the denture after each meal with a medium toothbrush to avoid gingival inflammation.

For the indirect pickup technique, two long transfer copings were screwed into implant fixtures and splinted with Duralay auto-polymerized acrylic resin (Duralay, inlay resin pattern; Reliance Company, Alsip, Illinois, United States), and a two-step rubber base impression (Silaxil rubber base impression material; Lascod, Florence, Italy) was taken as the custom-made acrylic resin tray was painted with a rubber base adhesive and then loaded by the medium-body rubber base impression material to record the mucosa of alveolar ridges. Then, a medium-body rubber base impression material was injected around the implants with their corresponding metal transfers. The implant’s analogs were tightened, and a cast was poured. On the cast, locator attachments were tightened, and the mandibular denture was hollowed above the locators. The maxillary cast was mounted on a mean value articulator and then the mandibular denture was mounted in centric relation and then an indirect pickup was done in the lab, while the articulator was closed. The mandibular overdenture was then clinically attached to the locators and occlusal adjustments were done using articulating paper.

According to Burns, retention was measured using a force meter device mounted on the force meter holder device. This device was used to mount the force meter perpendicular to the occlusal plane with a chin rest for the patient allowing the operator to measure the retention vertically and perpendicular to the patient’s occlusal plane (Fig. 3). The clinical retention of conventional complete dentures was first measured. After locator abutments were attached, all patients were measured for clinical retention of implant overdentures, as follows; the clinical retention of the implant overdenture with blue retentive caps was measured using a force meter device after 3 (T3) and 6 months (T6). The clinical retention of the implant overdenture with pink retentive caps was then measured clinically using a force meter device after 3 (T3) and 6 months (T6). This was done for each pickup method.

Extraoral calibration for the retention of locator retentive caps was done with the retentive values from the manufacturer. The locator abutment was
screwed with the analog fixture. Metal junction is attached to the locator metal cap acted as a hook and then a force meter device was used to measure the retention of blue processing inserts and then replaced by pink ones and measurements were evaluated.

After repeated cycles for retentive cap measurements, the mean retention force of blue retentive inserts was 1.095 lbs/4.871 N and the manufacturing value was 1.2 lbs/5.3 N, which represents 91.25% accuracy of retentive force measurement in this study. For pink retentive inserts, the mean retentive force was 2.293 lbs/10.2 N and the manufacturing value was 2.4 lbs/10.6 N, which represents 95% accuracy of the retentive force measurement in this study. Therefore, the accuracy of retentive force measured in this study could be considered within the range between 91 and 95%.

The retentive scores between observation times were compared using the Freidman exam. For pairwise comparisons, the Wilcoxon signed-rank test was applied. The Mann–Whitney test was used to compare these factors between the two groups. P values below 0.05 were deemed significant. Data analysis was done using SPSS statistical software for social science version 25 (SPSS Inc, Chicago, United States).

Results

A comparison between the retentive scores of blue retentive caps in group I is presented in Table 1. A statistically significant difference in retention scores after 6 months of use of the blue retentive cap was found ($P > 0.05$). Retention was statistically decreased with the advancement of time as measured by Freidman’s test, Ret_T0 (mean = 11.48) Ret_T6 (mean = 6.3).

However, using Wilcoxon signed-Rank test showed no statistically significant difference in retention after 3 months of use of mandibular overdenture. A statistically significant decrease in retention was shown after 6 months.

A comparison between the retentive scores of the pink retentive cap in group II is presented in Table 1. No statistically significant difference in retention scores after 6 months of use of the pink retentive cap was found ($P > 0.05$) as measured by Freidman’s test, Ret_T0 (mean = 25.2) Ret_T6 (mean = 18.3).

A comparison between the retentive scores of blue retentive caps in group III is presented in Table 1. A statistically significant difference in retention scores after 6 months of use of the blue retentive cap was found ($P > 0.05$). Retention was statistically decreased with the advancement of time. However, a comparison between different times by Wilcoxon signed-rank test showed no significant decrease after 3 months of use but only a significant decrease was found after 6 months of use of locator mandibular overdenture, Ret_T0 (mean = 11.9) Ret_T6 (mean = 6.2).

A comparison between retentive scores of pink retentive caps in group IV is presented in Table 1. A statistically significant difference in retention scores after 3 months and 6 months of use of the pink retentive cap was found ($P > 0.05$). Retention was statistically decreased with the advancement of time, Ret_T0 (mean = 28) Ret_T6 (mean = 18.1).

A comparison of retention scores of all inserts between groups of the study is presented in Table 2. A statistically significant difference in retentive scores was found between all inserts picked up

<table>
<thead>
<tr>
<th>Groups</th>
<th>Ret_T0</th>
<th>Ret_T3</th>
<th>Ret_T6</th>
<th>Significance</th>
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<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
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<td></td>
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<tr>
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<td>11.481</td>
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<tr>
<td>Group III</td>
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<td>10.240</td>
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<tr>
<td>Group IV</td>
<td>28.050</td>
<td>3.987</td>
<td>24.930</td>
<td>4.174</td>
</tr>
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</table>

**Highly statistical significant (<0.001).

Table 2. Comparison of retentive scores between different groups.

<table>
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<tr>
<th>Groups</th>
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<th>Ret_T3</th>
<th>Ret_T6</th>
<th>Significance</th>
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<tr>
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<tr>
<td>Groups I, IV</td>
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<td>8.403</td>
<td>31.00</td>
<td>7.694</td>
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<tr>
<td>Groups II, IV</td>
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<td>8.403</td>
<td>31.00</td>
<td>7.694</td>
</tr>
</tbody>
</table>

**Highly statistical significant (<0.001).
directly or indirectly as verified by the Kruskal–Wallis test except between group II and group IV, where no statistically significant difference in retention was found ($P = 0.061$).

**Discussion**

The crossover research design, as opposed to the longitudinal study design, enables patients to personally experience and compare all treatment approaches. In addition, crossover trials enable the use of fewer patients than parallel-group trials. The within-subject crossover studies also allow for the standardization of subject and denture parameters, which improves the accuracy of comparisons between prostheses in terms of patient satisfaction with each prosthesis.

CBCT was used in preoperative planning and evaluation of alveolar bone conditions. So, the height and width of alveolar bone available for implant placement were accurately assessed. Radiographic analysis of the bone quantity of the selected cases allowed the use of 13 mm length and 4.1 mm diameter implants in canine areas with safety-investing bones.

Also, CBCT was used in stent fabrication as the stereolithographic stent combined with the flapless surgical protocol used in our study allowed a minimum invasion, implant insertion precision, predictability, less postsurgical pain, and a shorter time to final rehabilitation.

Standard delayed implant loading protocol was used in the study to facilitate uneventful osseointegration, avoid soft tissue encapsulation, and improve implant survival rates, as shown in a study by Schimmel et al.

The force meter holder device used in our investigation combined the benefits of measuring retention both in vitro and in vivo. As this equipment was used, the measurement process was standardized to provide the most precise results possible while applying a pure vertical force perpendicular to the occlusal plane while taking into account the oral environment, which includes humidity, salivation, temperature change, and masticatory load.

The retention measurement in this study was started by the indirect pickup technique to avoid new denture construction and pickup implant transfer impression, which added more variables that affected the retention measurements.

Comparison between group I (indirect blue) with group II (indirect pink) showed a higher statistically significant difference in retention levels from T0 to T6 after 6 months of use. This was related to the difference in retention values of both inserts as supported by the manufacturer: blue insert (1.2 lbs) and pink insert (2.4 lbs). In addition, our in-vitro results supported the same results as the retention value of the blue insert was 1.09 lbs and of the pink insert was 2.29 lbs.

A statistically insignificant decrease in retention was found in retentive scores after 3 months of use of retractive caps in group I (indirect blue), group II (indirect pink), and group III (direct blue). These findings were consistent with previous studies, which concluded that, in general, for Locator, retention loss remains not significant after 100 000 chewing cycles (3 months). Nevertheless, a progressive decrease is observed until 1000–2000 insertion removal cycle IRC (i.e. 1–2 years of clinical service).

The presence of saliva and consistent occlusal force may be responsible for the mechanical wear of the retentive plastic cap as documented by Passia et al. and Payne and Solomons. The authors studied the wear and annual replacement of plastic caps for the attachment system. They found that after 6 months of clinical evaluation, the retentive values were decreased but the range of retention of locator attachments was still within the accepted range of required retention.

Moreover, this finding was in agreement with Wolf et al., Abi Nader et al., Rutkunas et al., and Mínguez-Tomás et al. who reported a significant decrease in retention values of locator and OT attachments after 6 months of denture insertion. They attributed the loss of retention to mechanical friction between male and female parts, which led to wear and permanent dimensional changes in nylon inserts.

Other studies attributed the significant loss of the locator retentive values to viscoelastic creep and the strain energy that is absorbed during insertion and removal that may be divided into elastic (recoverable) and plastic (permanent) components. If permanent deformation occurs, a rapid loss of retention will be observed.

Comparison between group I (indirect blue) with group II (indirect pink) showed a higher statistically significant difference in retention levels from T0 to T6 after 6 months of use. This was related to the difference in retention values of both inserts as supported by the manufacturer: blue insert (1.2 lbs) and pink insert (2.4 lbs). In addition, our in-vitro results supported the same results as the retention value of the blue insert was 1.09 lbs and of the pink insert was 2.29 lbs.

A statistically insignificant decrease in retention was found in retentive scores between group I (indirect blue) and group III (direct blue) or between group II (indirect pink) and group IV (direct pink) techniques with the advancement of time.

This was consistent with a study by Ahmed which reported no significant difference in retention of locator attachments, in both groups (direct and indirect pickup) throughout the study with the use of the same retentive insert.
O’Keefe et al. showed that incorporation techniques for locator housings, either direct or indirect, did not affect initial overdenture retention or rate of wear of locator retentive components over the study period.

After 6 months of overdenture insertion, the retention values of all groups were statistically decreased except for group II (indirect pink). This finding might be agreed with a study by Abi Nader et al., which assessed the effect of simulated mastication on the retention of different attachment systems for two-implant overdentures. It is estimated that the Locator, which has higher initial retention, would lose its superiority over the ball after 300,000 ml (9 months) also found a high level of maintenance needs for overdentures retained by locator attachments after 1 year of use.

In addition, this might be because group IV (direct pickup technique) muscles around the overdenture are physiologically adapting more quickly than group II (indirect pickup technique) during denture processing, leading to more denture settling and mucosal compressibility. A fulcrum was generated between the implants, forcing the denture to rotate during a direct pickup, according to studies, and this led to greater posterior denture settling in overdentures with a direct pickup approach than in overdentures with an indirect pickup technique. More activation and a quick loss of retention were caused by the rotation.34,35

Conclusion

Regarding the retention point of view, laboratory (indirect) pickup assembly of the locator attachments could be considered the technique of choice to avoid the difficulties of the intraoral (direct) pickup procedures as there was no statistically significant difference observed between both techniques.

Authors contribution

Amany A.E. Awad: performed prosthetic procedures and collected the data. Christine R.M. Ibrahim: did the surgical implant placement, performed prosthetic procedures, led the writing, and did the statistical analysis. Ahmed A.A. Habib: conceived ideas and led the writing, and final approval of the version to be published; agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any parts of the work are appropriately investigated and resolved.

Funding

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Data availability

All data in this clinical study are available on request from the corresponding author.

Conflicts of interest

There are no conflicts of interest.

References


