ORIGINAL RESEARCH

Analysis of Denture Base Displacement between Conventional Acrylic Removable Partial Dentures and Click Fit Partials for Kennedy's Class I and II Situations: An *In Vitro* Study

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Abstract

Aim/objective: The aim of this study was to evaluate the displacement of the denture base of conventional acrylic dentures and Click Fit partials in Kennedy's class I and II situations in the mandibular arch.

Materials and methods: Four removable partial dentures—two conventional clasp dentures and two attachment dentures (Click Fit)—were designed. The two conventional clasp dentures were retained by C (conventional) clasps, and the two attachment dentures were retained by rigid precision attachments. The displacement of denture bases and the movements of denture bases were investigated, and the influences of denture design were studied.

Result: The values obtained were statistically analyzed by using independent *t*-tests. For all statistical purposes, a *p*-value of ≤0.001 was considered significant. The results showed that mean vertical displacements (mm) of the conventional acrylic removable partial denture base for Kennedy's class I mandibular arch under 50, 75, and 100 N forces were 0.0317, 0.04377, and 0.06392, respectively, and those for Kennedy's class II mandibular arch under 50, 75, and 100 N forces were 0.04922, 0.09849, and 0.1522, respectively. Vertical displacements (mm) of the Click Fit removable partial denture base for Kennedy's class I mandibular arch under 50, 75, and 100 N forces were 0.02185, 0.03436, and 0.005365, respectively, and those for Kennedy's class II mandibular arch under 50N, 75N, and 100N forces were 0.0445, 0.07851, and 0.14457, respectively. The difference between the groups was statistically significant ($p \leq 0.001$).

Conclusion: The vertical displacement of the denture base retained by conventional C clasps was more than that of the denture base retained by rigid precision attachment. The displacement of the denture base tended to be less when the denture was designed with a rigid connection for the retainer and with cross-arch stabilization as in Kennedy's class I case.

Clinical implications: This research evaluated the vertical denture base displacement using different designs and retention types. Hence, it helped predict the prognosis of different removable partial denture base designs in various clinical conditions.

Keywords: Circumferential clasp, Denture base vertical displacement, Precision attachment, Removable partial dentures.

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Introduction

Long-term wear of removable partial dentures (RPDs) causes residual ridge resorption under the denture base and consequently decreases the mucosal support. *Conventional removable partial dentures* are cost-effective and a minimally invasive method of rehabilitation of partially edentulous arches.[1] Removable partial dentures with precision attachment are rigidly connected to abutment teeth. They are less likely to cause residual ridge resorption than non-rigid, flexible dentures. The removable partial dentures retained by these precision attachment retainers rehabilitate masticatory function and protect abutment teeth and residual ridges.[2] The purpose of this study was to evaluate stresses acting on abutment teeth and denture bases and to measure the displacements of denture bases when partial dentures are retained by rigid precision attachments or telescopic crowns.

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Materials and Methods

The study design consists of four specimens which were divided into two groups on the basis of their fabrication. The first group comprises two conventional acrylic partial dentures, and the second group consists of two Click Fit partial dentures. In each group, one specimen was fabricated according to Kennedy's class I design type and the second specimen according to Kennedy's class II design type. The specimens were tested on three different forces 50, 75, and 100 N simulating soft, medium, and hard chewing, respectively. The inclusion criteria of the study consisted of Kennedy's class I and class II design types in the mandibular arch and Rhein 83 precision attachments. The exclusion criteria consisted of Kennedy's class I, class II, class III, and class IV design

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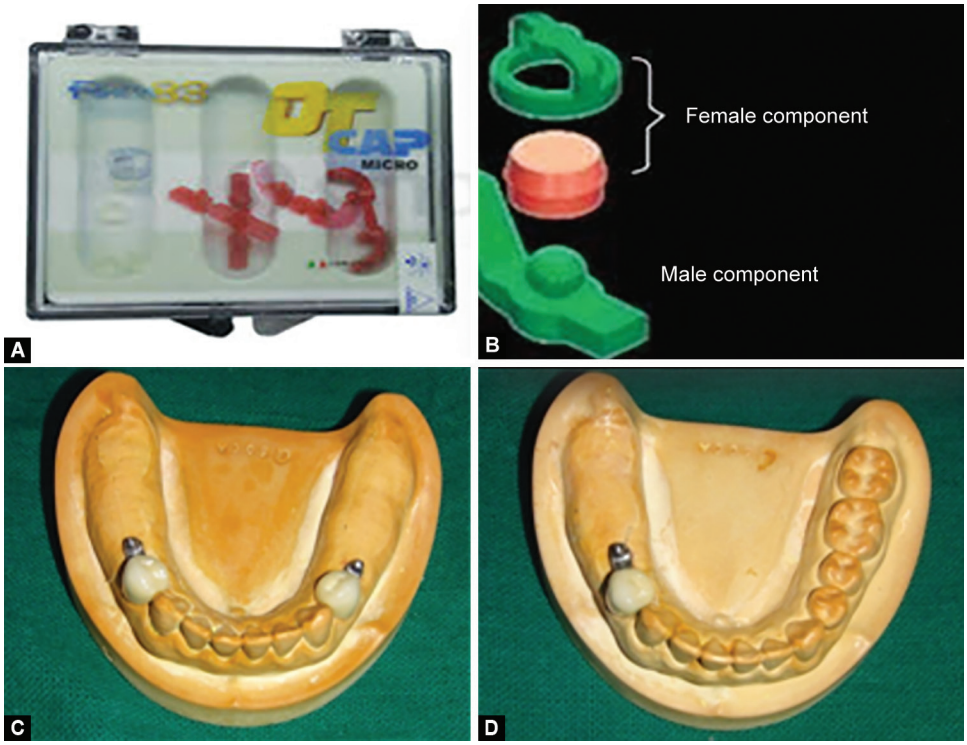


Figs 1A to D: Male and female components of Rhein 83 OT Cap and cast metal coping with ceramic buildup along with precision attachment

types in the maxillary arch and Kennedy's class III and class IV in the mandibular arch.

Mandibular silicone dentulous molds were poured, and four model casts were obtained. They were modified to obtain two Kennedy's class I and two Kennedy's class II design situations. For the conventional acrylic partial denture, circumferential clasps were fabricated using a 19-gauge stainless steel wire on tooth numbers 34 and 44 in Kennedy's class I model and on tooth numbers 44 on Kennedy's class II model. For the Click Fit model specimens, precision attachments were fabricated on tooth numbers 34 and 44 for Kennedy's class I situation and on tooth number 44 for Kennedy's class II situation.

After the tooth preparation on the model cast, coping was made with inlay casting wax, and the extracoronal OT Cap male castable attachment was joined with wax coping. Extra wax was removed and smoothened. The coping along with the male attachment was then casted in metal. The casting is then seated on the tooth of the model, and then ceramic buildup is done, simulating the natural tooth. The metal ceramic crown along with precision attachments was cemented on the model cast using luting cement (Fig. 1).

As an aid in testing the specimens, an upper member, which acts as the maxillary arch, was required. So a metal plate with indentation pins acting as the point contact of maxillary teeth was fabricated. Using Bluehill software, a metal plate was designed with dimensions similar to those of the model cast. A lathe cutting machine was employed, and a stainless steel die was cut in the desired shape and size and were input in the software. The steel plate with the indentation pins was fabricated so that a uniform contact on the denture on one side and model teeth on the contralateral side could be achieved. The model cast was used to fabricate the Click Fit partial denture. The female part is attached to the model cast, and then denture base wax up was done. Then, teeth arrangement was done using the metal plate acting as maxillary teeth contacts.

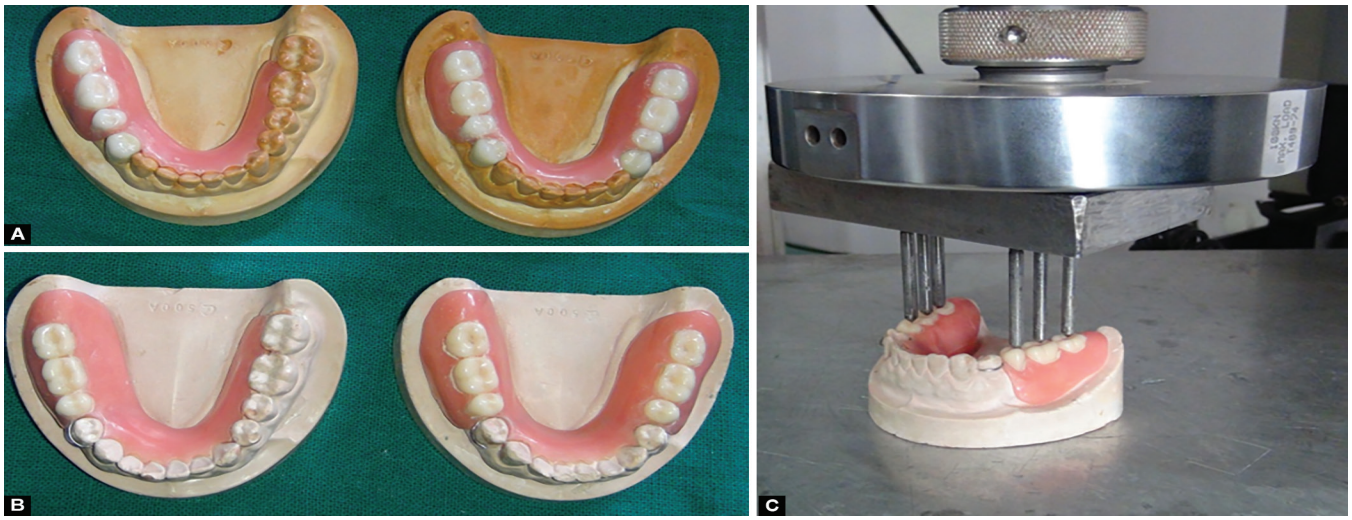
The conventional acrylic partial dentures and Click Fit partial dentures were fabricated accordingly. The dentures were cleaned, trimmed, and polished. The dentures were seated on the model cast with the cemented crown attached to the Rhein 83 OT Cap precision attachment at tooth numbers 34 and 44 in Kennedy's class I model and on tooth number 44 in Kennedy's class II model. The specimens were kept in water for 24 hours at 37°C.

The specimens were taken to "Central Institute of Plastics Engineering & Technology," Bhopal (CIPET), and the vertical displacement of the denture base was evaluated using a universal testing machine (INSTRON-3382). The specimen was gripped between the lower holding plate of the machine and the metal plate with the indentation pins fabricated earlier. The specimen was placed with the pins contacting the model teeth. The upper metal plate was then fixed to upper holding plate of the machine. Then force was applied gradually from 0 N to 100 N, and the readings were noted at 50, 75, and 100 N. Each specimen was tested 10 times, and the readings were recorded (Fig. 2).

Results

The data obtained were subjected to statistical analysis and were compiled systematically. The data analysis was done using Statistical Package of Social Sciences 25.0 software (SPSS Inc., Chicago, USA). Mean values and standard deviations were calculated in each analysis. The results were statistically analyzed by using independent *t*-tests. For all statistical purposes, a *p*-value of ≤0.05 was considered significant.

The results showed that the mean vertical displacement (mm) of the conventional acrylic removable partial denture base



Figs 2A to C: Finished and polished specimens: (A) Conventional acrylic partial dentures; (B) Click fit partial dentures; (C) Specimen under testing

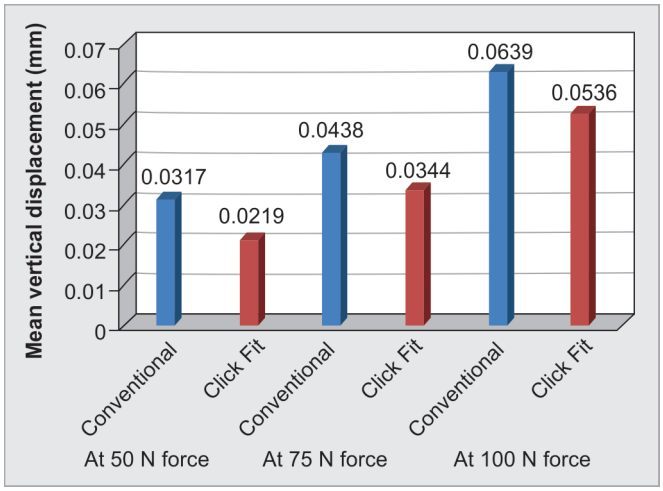


Fig. 3: Comparison of vertical displacement of conventional acrylic and click fit removable partial denture bases for Kennedy's class I mandibular arch under 50, 75, and 100 N forces

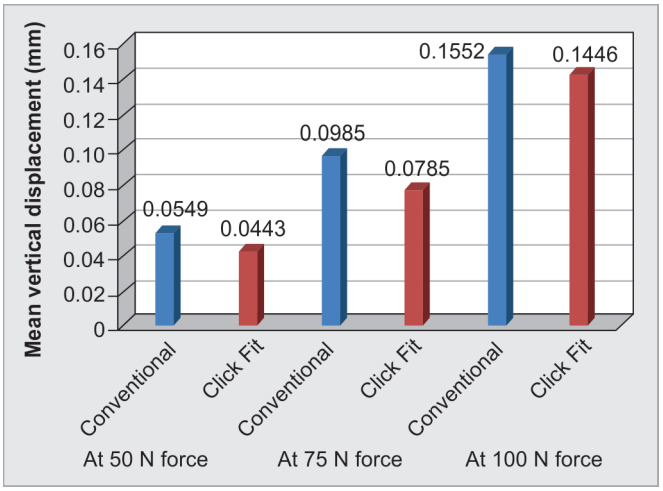


Fig. 4: Comparison of vertical displacement of conventional acrylic and click fit removable partial denture bases for Kennedy's class II mandibular arch under 50, 75, and 100 N forces

for Kennedy's class I mandibular arch under a 50 N force was 0.0317 ± 0.00524 and that of the Click Fit removable partial denture base was less 0.0219 ± 00119, and the difference between the groups was also statistically highly significant (p = 0.001). Under a 75 N force, the mean vertical displacement (mm) of the conventional acrylic removable partial denture base was 0.0438 ± 0.00586 and that of the Click Fit removable partial denture base was less 0.0344 ± 0.00237, and the difference between the groups was also statistically highly significant (p = 0.001). Under a 100 N force, the mean vertical displacement (mm) of the conventional acrylic removable partial denture base was 0.0639 ± 0.00545 and that of the Click Fit removable partial denture base was less 0.0536 ± 0.00111, and the difference between the groups was also statistically highly significant (p = 0.001) (Fig. 3).

The mean vertical displacement [in millimeter (mm)] of the conventional acrylic removable partial denture base for Kennedy's class II mandibular arch under a 50 N force was 0.0549 ± 0.00072 and that of the Click Fit removable partial denture base was less 0.0443 ± 0.00199, and the difference between the groups was also statistically highly significant (p = 0.001). Under a 75 N force, the mean vertical displacement (mm) of the conventional acrylic removable partial denture base was 0.0985 ± 0.00231 and that of the Click Fit removable partial denture base was less 0.0785 ± 0.00713, and the difference between the groups was also statistically highly significant (p = 0.001). Under a 100 N force, the mean vertical displacement (mm) of the conventional acrylic removable partial denture base was 0.1552 ± 0.01357 and that of the Click Fit removable partial denture base was less 0.1446 ± 0.00242, and the difference between the groups was also statistically significant (p = 0.025) (Fig. 4).

The results obtained show that the vertical displacement was least at a 50 N force, which relates to soft chewing, and was highest at 100 N, which relates to hard chewing. Also, the vertical displacement was least in Kennedy's class I Click Fit partial denture and maximum in Kennedy's class II conventional partial denture.

Discussion

Nowadays, the awareness and demand for the quality of dental treatment are increasing. Various rehabilitation modalities are

available for the replacement of partially missing teeth such as overdentures, clasp-retained removable partial dentures, removable partial dentures with precision attachments, and implants, one of which is a removable partial denture with a retained attachment system. Overdentures require the abutment teeth to be periodontally healthy. In some cases of overdentures, the abutment teeth require root canal treatment, which most patients do not agree with. The clasp-retained removable partial denture exerts forces on the abutment tooth due to the clasp design, and the clasp gives an unesthetic appearance. It also causes lacerations and ulcers in the mucosa if not properly designed. Implants require adequate bone height and width for its placement. Also, it is costly and involves longer treatment time.[3]

Shohet studied different types of retainers: —(1) the regular or conventional clasp, (2) back-action clasp, and (3) semiprecision attachment. The greatest degree of destructive distal stress was registered on the conventional clasp attachments. Under most circumstances, the back-action clasp caused less displacement and stress than the conventional clasp in all directions. The semiprecision attachment caused least displacement and stress in all directions. This result is consistent with that of our study, which also shows that there was least displacement when semiprecision attachment was used.[4]

Feingold et al. studied a laboratory model for the distal extension removable partial denture situation and investigated the effect of resilient and rigid precision attachment retainers on abutment teeth and denture base movement. It was found that both abutment teeth and denture base movement showed least displacement with the semiprecision attachments compared to the resilient attachments. They stated that the use of the semiprecision attachment retainer and cross-arch stabilization was effective in the reduction of the denture base movement. The observations of this study justify the results obtained in our study.[5]

In our study, vertical displacement was less in precision attachment dentures than in conventional acrylic dentures. Similar observations were seen in a clinical survey conducted by Owall over a 10-year period, in which he observed 26 of 27 removable partial dentures retained by clasps required relining, whereas the removable partial dentures retained by rigid precision attachments hardly required relining. The reason was that in conventional acrylic partial dentures, due to more vertical movements of the denture base, there is more ridge resorption, which in turn leads to reduction in the support of the prosthesis, thus necessitating relining of the denture base.[6]

Saito et al. studied five types of removable partial dentures: two precision attachment dentures, two telescopic dentures, and one clasp denture. The stress acting on the denture base of an attachment denture and a telescopic denture was less than that of a clasp denture. Also, the displacement of the denture base tended to be less when the denture was designed with a precision attachment with cross-arch stabilization. This result is in accordance with our study.[7]

The results of our study show that the precision attachment denture, that is, Click Fit partial denture, exhibited less vertical displacement than conventional acrylic dentures. Of all the specimens, the Click Fit partial denture for Kennedy's class I showed the least vertical displacement as it has a design with bilateral cross-arch stabilization.

The limitations of the present study are that only two designs of Kennedy's classification were studied, and there is further scope of research in other design types. Also, as the study was carried out *in vitro*, the effect of oral musculature could not be simulated.

Conclusion

The precision attachment in combination with partial denture construction offers us the possibility of making prostheses that are retentive, have good strength, are less troublesome, and do not harm the oral tissues of the patient. Our study concluded that vertical displacement is least in Kennedy's class I Click Fit partial dentures and maximum in Kennedy's class II conventional partial dentures. Further clinical studies are required to understand the effect of oral musculature and alveolar bone on displacement of partial dentures.

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