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RETENTIVE FORCE EVALUATION OF COBALT-CHROMIUM AND GOLD NANOPARTICLES REINFORCED FLEXIBLE CLASPS IN KENNEDY CLASS I REMOVABLE PARTIAL DENTURE#

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ABSTRACT

The purpose of this study was to evaluate retentive force of cobalt- chromium (Co-Cr) and nano-gold (AuNps) reinforced flexible clasps in Kennedy class I removable partial denture (RPD). Acrylic model represented Kennedy class I partially edentulous maxillary arch was fabricated and prepared for RPD fabrication. Traditional Co-Cr RPDs with gingivally approaching retentive clasp arm, thermopress flexible polymeric and AuNps reinforced thermopress flexible polymeric RPDs with circumferential retentive clasp arm were fabricated. Retentive force of RPDs were evaluated. The flexible polyamide and reinforced flexible RPDs revealed better preservation of retentive force rather than Co-Cr RPDs that showed a decrease in magnitudes after repetitive cycles.

INTRODUCTION

Missing teeth replacement is one of the most important needs for patients attending clinics to restore esthetics and/or function. RPD, fixed partial denture and dental implant were treatment modalities available for replacing missing teeth. Clinical findings, dentist guidance and patient related factors control the selection of the prosthesis [(1)].

Flexible RPDs are practically indicated in every partially edentulous condition. It is indicated in ridges where bilateral undercuts are present as it utilizes the undercuts in the ridge for retention, in cases of tilted teeth which develop an undercut where rigid partial dentures are tough to insert, in cases where clasps have to be placed in esthetic zone like on maxillary canine [(1)].

Flexible RPDs are also indicated in cases where conditions limit the use of implant and fixed partial dentures, in patients allergic to nickel, in patients with large bony exostoses that cannot be removed and in patients having microstomia, flexible partial dentures show good retention [(1-3)].

Retention of RPD is obtained from clasps, telescopes or some form of attachments. The visible components of clasp affect the aesthetics [(4-8)]. Co-Cr alloy, gold and titanium alloys are the most common alloys used for clasps [(9)]. Polyoxymethylene (POM) (acetal resin) is an alternative denture base and tooth coloured denture clasp material used since 1986 to deliver superior aesthetics [(10)].

The flexible clasp tip engages the undercut of the abutment to provide retention (0.25 – 0.75 mm undercut). The clasp assembly must provide retention, stability, support, reciprocation, encirclement, passivity and not affect aesthetics adversely. Clasp position, type, material, location in the dentition and the number of clasps are important [(9)]. The flexibility of the retentive clasp arm is influenced by the length, cross-sectional form, cross-sectional diam-

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eter, longitudinal taper, clasp curvature, and metallurgical characteristics of the alloy (11).

Clasps are classified into infrabulge and suprabulge clasps. The clasps are also classified according to material used to cast chromium clasps, wrought wire clasps, gold-alloy clasps, platinum-gold-palladium clasps and technopolymer clasps (thermoplastic). The infrabulge clasp has been thought to be more retentive than the suprabulge clasp (12).

The AuNps has low toxicity to biological systems. The gold NPs with the same shape and size exhibited different inhibitory effects by changing surface modifications agents. The gold NPs display excellent antibacterial potential for some Gram-negative and Gram-positive bacteria (13).

The purpose of this study was to evaluate retentive force of gingivally approaching Co-Cr and AuNps reinforced flexible clasps in Kennedy class I maxillary RPD.

MATERIAL AND METHODS

This in-vitro study was carried out on acrylic model (PMMA) fabricated and prepared for RPD fabrication. The model represented a Kennedy class I maxillary partially edentulous arch.

Spherical shape AuNps with 23±2 nm particle size in concentration of 400μg/ml (NanoTech Egypt for Photo-Electronics, El-Wahaat Road, Dream Land City, Entrance 3, City of 6 October, Al Giza) were incorporated within the polymer crystals. AuNps dissolved in ethanol was mixed with a ratio of 10% by volume to the pink flexible thermopress injection moulding polyamide crystals volume [bre. flex 2nd edition (Bredent, 5400F605, GmbH & Co.KG. Weissenhorner Str. 2, 89250 Senden, Germany)] just prior to manufacturing.

Two and half ml ethanol AuNps was added to a crystals half-filled cartilage (15g=22.5ml) and inserted in a 70°C preheated hot dry oven for 30 mins with intermitted shaking every 5 mins and confirmation of ethanol complete evaporation was done. Every two half-filled cartilages were collected together in one cartilage. The fully filled AuNps flexible thermoplastic crystals cartilages (45ml) were capped and ready for immediate heating, injection and manufacturing.

Three traditional Co-Cr RPDs with gingivally approaching retentive clasp arm (I-bar) (group A), three thermopress flexible polymeric RPDs (bre. flex 2nd edition) with circumferential retentive clasp arm (group B) and three AuNps reinforced thermopress flexible polymeric RPDs with circumferential retentive clasp arm (group C) were fabricated engaging 0.5 mm (0.02 inch) tooth undercut.

The acrylic model was modified to allow fixation with the universal testing machine [Lloyd instrument LR5K Japan. (Centre for Development of Small-Scale Industries, Faculty of Engineering, Ain Shams University)] accessory.

Ready-made plastic box compatible with the testing machine accessory fixing screw was fixed to the machine and filled with distilled water to allow retentive force evaluation test of the RPDs while immersed in water bath.

The RPD was inserted in position within the fixed acrylic model. A tensile load was applied to the RPD at a crosshead speed of 10 mm per min. until it was dislodged.

Retentive forces were evaluated [immediately, after 60 cycles and 360 cycles of manual (hand) insertion and removal] starting with the flexible polyamide RPDs followed by the Co-Cr RPDs.

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20, using *One Way Analysis of Variance (ANOVA) test* followed by post hoc analysis using LSD test with the significance level of $P \leq 0.05$ and a highly significant when $P \leq 0.01$.

RESULTS

The paired sample t-test showed that there was highly significant difference of tensile load (in Newton) required to remove:

- Group A from the acrylic cast between first time of use and after 360 cycles.
- Group A after 60 cycles and after 360 cycles of insertion and removal.

There was significant difference of tensile load (N) required to remove:

- Group A from the acrylic cast between first time of use and after 60 cycles.
- Group B after 60 cycles and after 360 cycles of insertion and removal.

There was no significant difference of tensile load (N) required to remove:

- Group B from the acrylic cast between first time of use and after 60 cycles.
- Group B after the first time of use and after 360 cycles.
- Group C from the acrylic cast between first time of use and after 60 cycles.
- Group C at the first time of use and after 360 cycles.
- Group C after 60 cycles and after 360 cycles of insertion and removal.

The One-Way Analysis of Variance (ANOVA) test followed by post hoc analysis using LSD test showed that there was a highly significant difference of tensile load (in Newton) required to remove the RPD from the acrylic cast at the first time of use, after 60 cycles and after 360 cycles of insertion and removal between group A and B, between group A and C and group B and C.

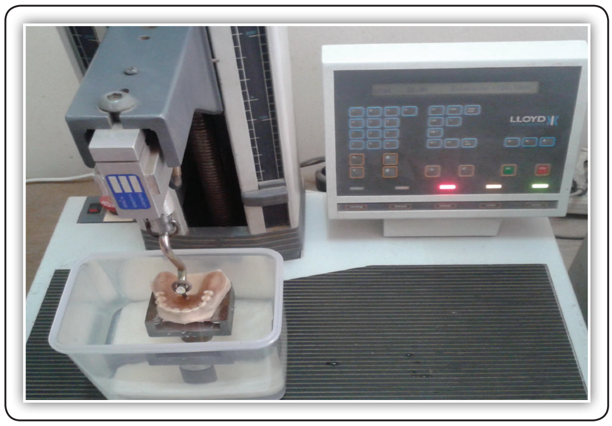

Fig. (1) Retentive force evaluation using the Universal testing machine.

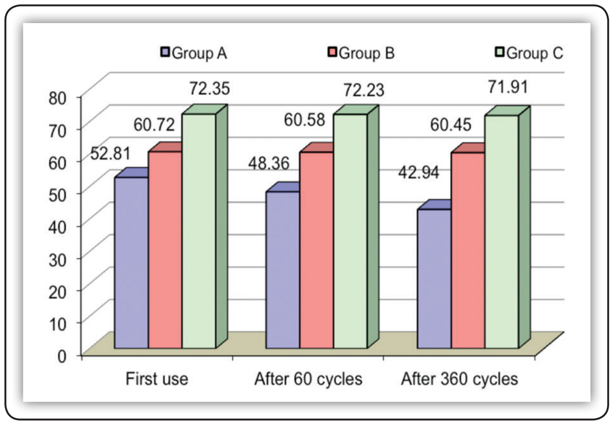

Fig. (2) Tensile load (in Newton) required to remove the RPD from the acrylic cast at the first time of use, after 60 cycles and after 360 cycles of insertion and removal for Co-Cr, flexible and AuNps reinforced flexible RPDs.

DISCUSSION

The Co-Cr RPDs, thermoplastic flexible resin RPDs, heat cured PMMA denture base resin materials were evaluated in this study to represent different alternatives for prosthetic restorations.

The polyamide thermoplastic flexible clasp arms evaluated in this study were designed just as wrought wire clasps in a circumferential form engaging wide and larger undercuts due to their flexibility. The flexible clasp design was correspondent with Fitton et al who stated that to gain adequate retention from thermoplastic clasp, the clasp should have a greater cross- sectional area than metal clasp (14). Therefor a 3.5 mm thickness of clasp with continuous in taper was used in this study (15, 16).

This study investigated the retentive force of gingivally approaching Co-Cr clasps and circumferential bre.flex.2nd.ed polyamide flexible clasps.

Adding AuNps to the thermopress bre. flex crystals were performed with crystals half-filled cartilage to allow adequate shaking for proper distribution of the ethanol AuNps. Every two half-filled cartilages collected after complete evaporation of ethanol providing a full-filled cartilage suitable for injection.

The insertion and removal cycles of the RPDs were done by hand (manually) to resemble the patient use, test was performed in a container filled with distilled water to simulate the oral environment. Two minutes time interval between every insertion and removal movements were allowed to provide a clasp strain release. The insertion and removal cycles were done starting by the flexible RPDs and finally the Co-Cr RPDs to avoid any possible surface scratches or abrasion of the acrylic model (17).

The retention test measures were recorded after sixty cycles as stimulation of two months of patient RPDs use with twice cycles of removal and insertion per day and after three hundred and sixty cycles simulating six months of patient use.

Polyamide resins (clasp and denture base material) were investigated also as it exhibits high flexibility, physical strength, heat and chemical resistance and the exceedingly rare allergy response. The polyamides are used primarily for tissue supported removable dentures because the stiffness is not enough for usage as occlusal rests or prostheses parts that need to be rigid (18, 19). All the materials tested were a shade of pink due to its common use in prosthodontic practice (20).

These results came in agreement with the results of Meenakshi A. et al (10), Arda T. et al (17), Mohamed T. et al (21) and Abdel-Rahim NY. et al (22) that the mean retentive force of the Co-Cr clasps decreased in the test cycles. The mild decrease in retentive force showed no noticeable effect on the RPDs retention.

The tensile load (N) required to dislodge the Co-Cr RPDs from the abutments undercut were less than thermopress bre.flex flexible polyamide RPDs and AuNps reinforced bre.flex flexible polyamide RPDs which had the highest values in first use, values after 60 cycles and values after 360 cycles. These results came in agreement with Fitton et al and Turner et al who stated that the flexible resin clasp can engage wide and larger undercuts due to flexibility (14-16).

These results disagree with the results of Meenakshi A. et al (10), Arda T. et al (17), Mohamed T. et al (21) and Abdel-Rahim NY et al (22) that the retentive force of the Co-Cr clasps were the highest values in the test cycles. The disagreement came out as a result of difference in clasp design for the thermopress bre.flex flexible polyamide and AuNps reinforced bre.flex which designed circumferential form engaging wider undercut area rather than Co-Cr I-bar clasp.

CONCLUSION

Within the limitation of the laboratory testing conditions of the present study; the AuNps reinforcement of the bre.flex flexible thermopress polymeric resin increased the retentive force of the RPDs, the Co-Cr RPDs showed the highest decrease in retentive force within the repetitive cycles than flexible RPDs.

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