EGYPTIAN DENTAL JOURNAL
VOL. 66, 485:494, JANUARY, 2020
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
FIXED PROSTHODONTICS, DENTAL MATERIALS, CONSERVATIVE DENTISTRY AND ENDODONTICS
www.eda-egypt.org • Codex : 78/2001 • DOI : 10.21608/edj.2020.79124

INFUENCE OF TOOTH-IMPLANT SUPPORTED TELESCOPIC OVERDENTURES WITH CERVICAL CLEARANCE ON SUPPORTING STRUCTURES OF UNILATERAL DISTAL EXTENSION RIDGE

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ABSTRACT

Aim: This study aimed to evaluate the influence of tooth -implant supported telescopic partial overdentures with cervical clearance on the supporting structures of unilateral distal extension removable partial dentures.

Materials and methods: Twelve male partially edentulous patients exhibiting lower Kennedy class II (lost second premolar and molar teeth on one side) opposed by completely edentulous maxilla were selected. Single unilateral implant was placed in the edentulous first molar area of the distal extension ridge. Patients were rehabilitated by Maxillary complete dentures and mandibular tooth-implant retained telescopic partial overdentures. Patients were randomly divided by using closed envelope into two equal groups; according to the design of telescopic crown. **Group I**; patients received cervically relieved telescopic crowns, (cervical clearance), and **Group II**; patients received telescopic crowns with no relief between primary and secondary copings, (precise fit). Measuring probing depth, and radiographic changes in marginal bone height of the abutments, and crestal bone height of the residual ridge, were evaluated at 3, 6, 9 and 12 months after denture insertion.

Results: Statistical analysis revealed a significant increase in the means of the measured abutments probing depth, change in alveolar bone height of the abutments, and crestal bone height of the residual ridge (mm) during the follow up time intervals in both group I (cervical clearance) and group II (precise fit). Abutments having telescopic crowns with precise fit showed significantly higher probing depth and change in alveolar bone height compared to those with cervical clearance. There was no statistically significant difference in the change in crestal bone height between the two studied groups at the end of the study period.

Conclusions: Telescopic retainers with cervical clearance are recommended for unilateral partial dentures compared to those with precise fit as they have a lowest destructive effect on the change in probing depth and height of the marginal bone of the abutments. However, the change in the crestal bone height was not significantly affected by the design of the telescopic retainers.

KEY WORDS: Distal extension partial denture, telescopic crown, cervical clearance, precise fit.

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INTRODUCTION

Modern dentistry aims to restore the normal contour, function, esthetics, comfort, and health regardless of the atrophy, disease, or injury of the stomatognathic system.[1] However, the lost more teeth, lead to more difficulties in performing this objective with conventional dentistry. Today dental implant is used to supply retention and support for prosthetic substitution of teeth that has been lost.[2]

A conventional removable partial denture is a applicable treatment solution for partially edentulous patients due to economical and senility reasons. Denture stability, good retention, oral comfort and satisfactory aesthetics are important factors for a successful rehabilitation with removable partial dentures. [3,4] . Preserving good oral hygiene and adequate distribution of functional forces between the abutment teeth and the alveolar ridge enhance the prognosis of this treatment modality. [5,6]

Limitation of unilateral removable partial dentures as (class II Kennedy RPDs) is due to poor retention and stability, dual support system, and anatomical characteristics . Such prostheses are less stable as they have a reduced effect of cross arch stabilization[7,8]. The levers formation due to lack of distal abutment support during the performance of functional forces that are potentially harmful to the supporting structures. [9].

Telescopic crowns were revealed by Starr in 1886; and were introduced as retainers for removable partial dentures.[10] This retainer, also, known as crown and sleeve retainer, comprises double crowns; an artificial outer crown constructed to fit over a coping cemented to the abutment tooth. [11] Many studies described that, telescopic crowns retained partial denture is a confinable restoration giving adequate clinical longevity that realize both enhanced function and patient satisfaction. [12-15]

The use of telescopic crowns allows clinicians to reach a decision between conventional and implant supported prostheses to successfully treat cases that are difficult. [16] Also, this system is indicated when the abutments are not parallel and when there is no appropriate path of insertion. [17-18]

Reconstructions of telescopic retainer are specific hybrid combination of fixed abutments (as primary inner crowns) and removable prostheses (frameworks), [19] which enhance retentive and stabilizing property with splinting action; [20,21] and have an esthetic advantage over clasp retainers.[22]. However, some disadvantages of double crown–retained removable partial dentures as, the need for tooth great reduction (1 to 1.2 mm labially) to provide enough space for the inner and outer crown, and to avoid over contouring design, this causes high risk of root canal treatment,[23] especially in younger patients. [24-25],the increased costs[26], and the challenging technical production. [27].

Telescopic retainers are classified according to relation between the inner and outer components; into two types; rigid interlocked telescopic units and telescopic units with built in resiliency. [20] The greater the mechanical friction can gained by more parallel the walls of the telescopic retainer, and the less the taper angle of the coping. This promote interlocking between the coping with the overlying crown and results in high retentive force. Rigid design of telescopic crown was consider to be more biologic and tolerated by the abutment when occlusal forces are applied. [28] However, in a study to determine the forces induced by non-tapered versus tapered telescopic retainers on free end base supporting structures, it was found that less forces were induced with tapered crowns compared with non-tapered crowns. Decreasing the taper angle was thus recommended when the condition of the abutment is more favorable than the condition of the residual ridge. [29]

In distal extension removable partial dentures, preferably use telescopic crowns designed with stress releasing effect which could be carried out by increasing the taper angle, create 0.3-0.5 mm occlusal or gingival relief between the coping and the secondary crown or by reducing the height of

the crowns. This reduces torque on abutment teeth by allows movement of the denture.[30-32].

The clearance fit system (as the Marburg double crown system is an example) allows a minimal, invisible lateral movement and a smooth effortless gliding along the axis of the path of insertion. [24] Another design involving a telescopic crown with a conically tapered coping and 0.003 to 0.01 inch space cervically between the coping and the outer crown was introduced to allow for rotation of the secondary crown. This design allows stress distribution to the abutments and to the other side of the arch when lateral force was applied on one side of the arch. [33]

The successful rehabilitation with removable partial dentures requires the presence of healthy periodontal tissues. Thus, prosthetic and periodontal treatments are not only interrelated but also interdependent. [34] Rehabilitation with telescopic retained removable partial dentures recorded the least amount of bone loss, and the lowest gingival index scores compared to patients rehabilitated with extra-coronal attachments and also, with clasp retained removable partial dentures. [35]. However, the effect of each of accurately fitted telescopic units and those with clearance fit on the supporting structures is an area of concern. Consequently, the aim of this study was to evaluate the effect of telescopic crown retainers with cervical clearance compared to precisely fitted retainers on the supporting structures of unilateral distal extension removable partial dentures.

MATERIALS AND METHODS

Twelve male partially edentulous patients aged range between (43 and 61 years), were selected for this study from the Prosthodontic clinic, Faculty of Dentistry, Misr University for Science and Technology. All patients had mandibular Kennedy class II with first premolars as the last standing natural tooth opposed by completely edentulous maxilla. All selected patients had well developed edentulous ridge with firmly attached mucosa, sufficient inter-arch space as well as sufficient bone height in the first molar areas of the mandible (at least 12 mm above the inferior alveolar canal as verified by panoramic radiographs), and good bone quality, abutment were free from caries, periapical or periodontal diseases as revealed by clinical and radiographic examination. Patients with poor oral hygiene, abnormal jaw relationship, or those having a medical problem that may affect the oral environment and the condition of removable partial denture supporting structures as diabetes, osteoporosis, smoking habits, immune deficiency were excluded.

After explaining the study design, an informed consent was obtained from each patient before commencement of the study. Supra and subgingival scaling and root planning were performed to all patients before starting removable partial denture construction.

Surgical and prosthetic procedures

Partial dentures were constructed for all patients following same standardized method, including the impression technique, jaw relation procedure and balanced occlusion using same denture teeth type. Patients were recalled for follow up 24 hours after partial denture wearing, 3 days and one week later.

The patient's lower partial denture was duplicated into transparent self cured acrylic resin with a metal ball attached at the implant proposed site to act as a radiographic stent. Digital panoramic view was taken for each patient to evaluate the height of the available bone. Ridge mapping was done to assess the alveolar bone width at the implant proposed site[36]. The radiographic stent was modified to serve as a surgical stent to mark the position of the implant on the ridge.

Single unilateral implant (3.7mm in diameter and 11.5 mm in length, Implant Direct LLC, Spectra System TM Screw Plant® Calabasas, California), was placed in the edentulous first molar area of

the distal extension ridge using the standardized two stage submerged surgical protocol. Implants were exposed four months later, and healing abutments were placed. Maxillary complete denture and mandibular removable partial dentures were constructed and delivered to the patients. Dentures were relieved opposite to the healing abutment to avoid overload the implants during osseointegration period.

Patients grouping

Patients were randomly divided equally by closed envelope to one of two groups. **Group I;** patients received mandibular telescopic crown retained removable partial overdentures with built in cervical clearance. **Group II;** patients received mandibular telescopic crown retained removable partial overdentures with precise fit between the primary copings and secondary crowns.

Abutment preparation and construction of primary copings :

In both groups; the first premolar adjacent to the edentulous ridge was reduced buccally, proximally and lingually, with chamfer finish line to receive the primary copings. Avoid both over and under reduction. Preparation reduction of the occlusal surface in height was carried out to allow for adequate space for both the coping and secondary crown without encroaching on the interocclusal space.

The short (indirect) transfer coping was screwed in the internal hex of the implant and closed tray impression technique was completed using a special tray and medium bodied polyether impression material (Impregum polyether impression material, medium body, 3M, USA). The implant analogs were attached to the transfer copings and the assembly was plugged into the fitting surface of the impression. Injection of soft silicon around coping- implant analog junction, the impression was then poured in improved dental stone (Lascod Spq, Sestofino (FI), Italy), and plastic abutment was screwed into the implant analogs on the resultant cast.

The cast was mounted on the surveyor table, and surveyed to select the proper path of insertion. The first premolar tooth and the implant plastic abutments were waxed with blue inlay wax. The wax pattern of first premolar tooth and the implant plastic abutments were milled using a 4° bur of a milling machine (Degussa AG, Frankfurt, Germany), on the selected path of insertion. The wax patterns were invested and Cast in nickel chromium alloy, positioned in place over the cast and refined again by milling machine to obtain a 4° primary conical crowns. Primary conical crowns of premolar abutments were cemented (with G- Cem Capsule, GC corporation, Tokyo, Japan) in place and primary conical crowns of the implants were screwed to the implants at 35 Ncm torque and the screw opening was closed with composite resin (Fig.1).

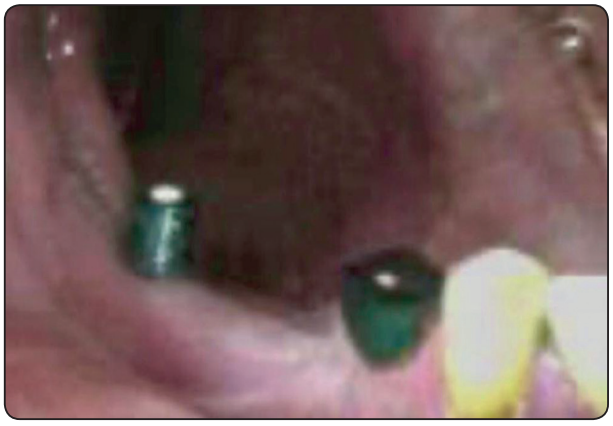

Fig. (1): Primary conical crowns of premolar and implant abutments in place.

Construction of the metal framework with telescopic crowns

Secondary impression was made in pre-constructed acrylic special tray using rubber base impression material and master cast was surveyed and waxed up for relief and block out of undesirable undercuts .**For group I**; a relief space of 0.3-0.5 mm was created cervically using platinum foil on the primary coping. The modified master cast was then duplicated to produce the refractory cast. **Group II;** involves precisely fitted telescopic units with no relief between the primary copings and

the telescopic crowns. Wax patterns were prepared and cast in cobalt chromium alloy (BEGO, Wironit alloy, Bremen, Germany).

The metal framework was tried in the patient's mouth to ensure precise fit of the telescopic crowns over the metal copings in group II and the occlusal two thirds of group I, presence of cervical relief in group I and adequate fit of metal framework without interference.

Telescopic overdentures were then fabricated following the design concept utilized for all mandibular partial overdentures , tooth support and direct retention was obtained from double conical crowns on the abutments, and double Aker clasps on the first and second molars on the intact side. The indirect retention was obtained from occlusal rests on the first premolar teeth of the opposite intact side. Lingual bar major connectors were used for all removable partial overdentures and semi-anatomic acrylic resin teeth (Vitapan®, Vita Zahnfabrik, Bad Säckingen, Germany) were arranged for balanced occlusal contact. [37]

The secondary copings were picked to the fitting surface of the partial overdentures with self-cure acrylic resin to ensure passive fit (Fig.2).

Periodic visits were scheduled to eliminate causes for patients' complaints and ensure maintenance of adequate oral hygiene.

Fig. (2): The secondary copings of abutment tooth and implants picked to the fitting surface of the partial overdentures

Clinical and radiographic parameters assessed

Assessment of the periodontal condition of abutments was carried out by measuring probing depth, and by radiographic measurement of marginal bone height around abutments. Residual ridge crestal bone height was measured to assess bone loss. Records and data required for this study were collected and evaluated at time of denture insertion (baseline), and at scheduled follow-up visits 3rd, 6th, 9th, and 12th months after denture insertion.

Probing depth measurement

William's graduated periodontal probe (Williams, Hu-Friedy 60618 Chicago) was used to measure the distance between the base of the pocket to the top of the coping at previously marked points. The probe was inserted in line with the long axes of the abutments until resistance was encountered [38]. The measurements were made at the mesio- buccal, mid-buccal, disto-buccal and mid- lingual of abument tooth. The average of four readings was calculated, and probing depth was measured on mesial, buccal, distal, and lingual surfaces around the implant. The gingival margin was used as a reference line for the location of the mucosal margin.

Radiographic assessment:

Radiographic follow-up was performed for assessment of marginal bone height, mesial and distal aspect around abutment teeth, implants, and crestal bone height, at specially marked points. Cemento- enamel junction and implant shoulder were used as reference points. To assess the changes in bone height, the distance between the implant shoulder and the first visible bone-implant contact was determined by measuring the squares on radiograph and expressed in millimeters.

The X-ray unit with long cone paralleling device was used, serial standardized radiographs was performed. Individual radiographic acrylic template was fabricated by duplicating the overdenture of

the patient and having the imprints of the Rinn XCP bite plate.* [39] This was done in an attempt to standardize the film focal distance and angulation and to provide reproducible positioning of the film in relation to the abutment, the edentulous ridges and the X- ray source. A metal wire was embedded in the fitting surface of the template opposite the crest of the ridge and notched at a distance of 20mm from the abutment . This was used as a fixed reference point for measuring bone height of the edentulous ridges. [40] The film was exposed by the X-ray machine (Orix-65 mobile X-ray machine, ARDET srl, Italy) at 65 kilovolt, 20mA for 0.75 seconds. The exposure parameters were fixed for all patients and over the follow up period. Periapical radiographs were processed in automatic processor. They were scanned to the image processing software of the computer (DBS Win Durr dental, Germany) that was capable for measuring bone height after calibration of the image. The scanned images of each patient were interpreted to record bone height mesial and distal to the abutments and the residual ridge by one examiner at two different times. The mean of the two readings was calculated. This was carried out at each scheduled follow-up visit. The amount of bone loss was calculated by subtracting the measured distances between each two consecutive radiographic evaluations. The data collected was subjected to statistical analysis.

Statistical analysis

Statistical analysis was performed using statistical package for social sciences (SPSS 16.0). Repeated measures ANOVA was used to test the effect of time on the probing depth, change in marginal bone height and crestal bone height within each group. When ANOVA revealed significance, Tukey HSD test was used for pair-wise comparisons between different time periods. Student t-test was used to compare between the two designs at each time interval. The significance level was set at $P<0.05$.

RESULTS

1. 1-Effect of time on probing depth

The mean difference of the probing depth (mm), was increase during the follow up time intervals in both group I (cervical clearance) and group II (precise fit) patients as shown in table (1). This increase was statistically significant ($P<0.05$) at the last interval (9-12 m), of the study period in group I. However, this change was statistically significant at the interval (6-9 m), (9-12 m), of the study period in group II.

2. Effect of design on probing depth

By comparing the effect of design on probing depth changes in group I and group II revealed a significantly higher probing depth for group II (precise fit) compared to group I (cervical clearance) at the different time intervals.

3. Effect of time on the change in the marginal bone height

The mean change of the marginal bone height (mm); was increased during the follow up time intervals in both group I (cervical clearance) and group II (precise fit) patients as shown in table (2). This increase was statistically significant ($P<0.05$) at the last interval (9-12 m), of the study period in group I. However, this change was statistically significant at the interval (6-9 m), (9-12 m), of the study period in group II.

4. Effect of design on the change in the marginal bone height

By comparing the effect of design on changes in marginal bone height in group I and group II revealed a significantly higher changes in marginal bone height for group II (precise fit) compared to group I (cervical clearance) at the different time intervals.

* Rinn Corporation, XCP instruments for extension cone paralleling technique. USA.

5. Effect of time on the change in the crestal bone height

The mean change of the crestal bone height (mm); was increased during the follow up time intervals in both group I (cervical clearance) and group II (precise fit) patients as shown in table (3). This increase was statistically significant (P<0.05) at the last interval (9-12 m), of the study period in group I. On the other hand, in group II, this change showed statistically significant change in crestal bone height at the interval (6-9 m) compared to (insertion-3m). Also, there was a statistically significant change at (9-12 m), of the study period compared to the other time intervals.

6. Effect of design on the change in the crestal bone height

By comparing the effect of design on the change in the crestal bone height between groups, the results revealed an insignificant difference between the two designs at different time intervals except for the (3-6 m) time interval that showed a significant difference between the two groups.

TABLE (1) Means, standard deviation values (SD) for the probing depth (mm) at different time intervals of each group and between groups.

Design / Time Interval	Group I (Cervical clearance)	Group II (Precise fit)	P-value
	Mean (SD)	Mean (SD)	
Insertion-3 month	0.21 (0.019)	0.27 (0.028)	0.0005 *
3 - 6 month	0.26 (0.03)	0.36 (0.0396)	0.0004 *
6-9 month	0.28 (0.035)	0.46 (0.0574)	<0.0001 *
9-12 month	0.37 (0.047)	0.64 (0.0741)	<0.0001 *
Insertion-12 month	1.09 (0.08)	1.67 (0.13)	<0.0001 *

Means significant at P <0.05

TABLE (2) Means, standard deviation values (SD) for the change in the marginal bone height of abutments at different time intervals of each group and between groups.

Design / Time Interval	Group I (Cervical clearance)	Group II (Precise fit)	P-value
	Mean (SD)	Mean (SD)	
Insertion-3 month	0.023 (0.00273)	0.025 (0.00325)	0.0283 *
3 - 6 month	0.018 (0.00238)	0.027 (0.00465)	<0.0001 *
6-9 month	0.025 (0.00408)	0.041 (0.00473)	<0.0001 *
9-12 month	0.044 (0.00574)	0.059 (0.00812)	0.0007 *
Insertion-12 month	0.103 (0.01133)	0.156 (0.01648)	<0.0001 *

Means significant at P <0.05

TABLE (3) Means, standard deviation values (SD) for the change in crestal bone height at different time intervals of each group and between groups.

Design / Time Interval	Group I (Cervical clearance)	Group II (Precise fit)	P-value
	Mean (SD)	Mean (SD)	
Insertion-3 month	0.023 (0.004)	0.019 (0.005)	0.2388
3 - 6 month	0.039 (0.007)	0.029 (0.008)	0.018 *
6-9 month	0.043 (0.007)	0.046 (0.0092)	0.6553
9-12 month	0.075 (0.016)	0.071 (0.014)	0.6276
Insertion-12 month	0.168 a (0.0336)	0.161 a (0.0272)	0.3468

****: Means significant at P <0.05***

DISCUSSION

Dental implants have become the treatment of choice in many, if not most, situations when missing teeth require replacement. Successful rehabilitation with removable partial overdentures for long range is mainly dependent on the preservation of supporting tissue structures especially the abutment teeth. Improperly designed restorations could adversely affect the abutment teeth and the residual supporting structures. [24,34] Therefore, every effort must be made to biomechanically design removable partial overdentures. Unfortunately, the use of implants as an additional retainers with telescopic over denture for rehabilitation in partially edentulous patients has rarely been discussed in the literature. [27] This study was thus encourage to evaluate the effect of two telescopic tooth-implant overdenture designs on the supporting structures. The principles was to determine whether; telescopic units with cervical clearance fit would provide an extra benefit in preserving the supporting structures of tooth-implant telescopic overdenture compared to those with precise fit.

Clinical probing were selected because they give direct results without need for special equipment [41,42], and is regarded as an important and reliable diagnostic parameter in the continuous monitoring of both periodontal and peri-implant tissues as stated by Niklaus *et al*.[43]

Patients were instructed for strict proper oral hygiene before overdentures construction and after delivery which might reduce the possibility for microbial invasion and exclude the effect of improper oral hygiene on the health of periodontal tissues, [37] and to facilitate correlation of the changes occurring in the supporting structures of partial overdentures to variation in the design.

A parallel long cone technique was used to avoid any elongation or shortening of the images. Moreover, this technique eliminates the possibility of superimposition over other structures [39].

A significant increase in the measured probing depth of abutments supporting tooth-implant telescopic overdentures was detected throughout the study period, that was shown at 9 months for the cervical clearance group and at 6 months for the precise fit group. However, this change is considered within the normal previously reported range of change in probing depth (0.5-3 mm). [44]. As this change was manifest in the two groups, it could be correlated to alteration in the oral ecology and to the stresses produced by introducing partial overdentures to the oral cavity. [45]

The change in probing depth that clarify earlier in abutments bearing telescopic crowns with precise fit, could be described by the fact that extra stresses are transmitted to the abutments by this design. The significantly reduce change in probing depth for the telescopic crowns with cervical clearance could be refer to the stress releasing effect provided by the telescopic retainers with cervical clearance compared to those with precise fit .

In this study, significant reduction was detected in the marginal bone height and the residual ridge height throughout the study period irrespective of the differences in the design. This finding is appropriate with the results of previous studies. [35,46] Bone loss could thus be refer to chronic progressive process that may be enhanced by functional forces encouraged by the telescopic partial overdenture and exceeding the physiologic limit of tissue tolerance. [47-48]. Regardless of all the effort made to control base movement by using the implant and following biomechanical designing and construction of removable overdenture for all patients.

Radiographic assessments detected a significant decrease in the height of the marginal bone for group II (precise fit), compared to group I (cervical clearance). The more frictional fit during insertion and removal between the telescopic units could have applied torque action on the abutments. Conversely, in case of cervical clearance group, less grip between the primary and the secondary crowns might have allowed a more stress releasing effect.[46,49] However, the insignificant difference

in the change in crestal bone height with the two different telescopic designs is may be due to the enhanced support provided by combined tooth-implant retained telescopic prostheses without consideration of their design, which in turn reduced base movement and minimized the rate of bone loss.[46]

This study showed that; telescopic crowns with cervical clearance have a less damaging effect on the measure change in probing depth, and, marginal bone height, without changing the crestal bone height, as detected by the insignificant difference between the two tested designs in the change in crestal bone height at the end of the study period.

CONCLUSION

1. Telescopic crowns with cervical clearance (group I) had less increase in probing depth than those with precise fit (group II)
2. Loss of marginal bone height was significantly higher in group II (precise fit) than in group I (cervical clearance)
3. Crestal bone level was not affected by the design of telescopic crowns

RECOMMENDATION

Telescopic crowns with cervical clearance are recommended as retainers for unilateral tooth-implant supported overdentures

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