

Prosthetic and biological complications of implant-retained fixed versus removable telescopic overdentures: randomized controlled clinical trial

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Background/aim

Implant-supported prostheses proved to solve a lot of problems and difficulties associated with edentulism, yet some complications continued to appear after using the different modalities of implant-supported prostheses, so this study aimed to count and analyze the possible prosthetic and biological complications of implant-retained fixed versus removable overdentures.

Patients and methods

The study was conducted on 22 completely edentulous patients selected from the Outpatient Clinic of Prosthodontic Department, Faculty of Oral & Dental Medicine, Badr University, Egypt. They were distributed randomly into two groups: group I received implant telescopic overdentures, group II received fixed detachable screw-retained implant-supported prostheses, and prosthetic and biological complications were evaluated after 1, 3, and 6 months.

Results

The present results indicated that χ^2 test was performed for significance evaluation between both groups in biological and prosthetic complications. In biological complications, it revealed a significant difference in relining after 6 months between both groups as *P* value less than 0.05. While for prosthetic complications, there was a significant difference between both groups in tooth wear and tooth separation after 6 months as *P* value less than 0.05.

Conclusion

Regarding prosthetic complications, telescopic overdenture showed a higher incidence than hybrid fixed screw-retained screw looseness and screw fracture. Regarding biological complications, telescopic overdenture showed the same incidence as hybrid fixed screw-retained implant looseness with a higher incidence of denture relining and lower incidence in peri-implant mucositis.

Keywords:

complications, edentulous patients, fixed screw-retained, implant overdenture

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Introduction

Edentulism can be restricting to the patients and has a negative effect on the quality of life [1]. The only solution for restoring edentulous patients was the conventional complete denture prostheses. Full-mouth rehabilitation becomes available with the revolution of dental implantology while using a removable or fixed dental prosthesis [2]. Many factors influence determining between fixed and removable prostheses such as the interarch space existing and relationship, intraforaminal space, cost, and patient's favorite [3]. The implant-supported overdentures are considered a regular treatment of choice in an edentulous arch [4], as they are considered less complex, financially reasonable, and less invasive with more expectable and acceptable results in patients complaining of stability and

retention with conventional dentures [3]. On the other hand, fixed implant-supported full-arch screw-retained dental prostheses are commonly used in implant treatment for edentulous patients and have established a high long-term success rate [5]. When evaluating implant treatment, we must consider both the clinician's and the patient's perspectives. The most significant considerations for prosthodontists are implant survival, durability, and the rate of prosthesis problems. It is preferable to use the term 'time to retreatment' to describe the longevity of an implant prosthesis [6].

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Biologic and prosthetic complications are the two types of implant prosthesis complications. Biologic complications are problems with implant function that affect the peri-implant tissues. Early and late implant failures, as well as adverse reactions in the peri-implant hard and soft tissues, are over the problems. Mechanical harm to the implant, implant components, and superstructures are referred to as prosthetic complications [7]. Furthermore, prosthetic difficulties after the final prosthesis is inserted may or may not result in implant loss, but they can increase the need for repair and care [8]. In healthy peri-implant tissue, there may be an increase of probing pocket depth over time (≥ 4 mm), with no bone loss or disease. Similarly, acute inflammation in the peri-implant mucosa is not always indicated by bleeding on probing [9].

Attention must be paid to numerous elements that can contribute to prosthetic issues during and after the restorative phase to minimize potential problems. The loosening or fracturing of the attachment screws is a common complication associated with the prosthetic restoration of dental implants. The amount and direction of the oral forces, as well as the strong constraints of the components, induce this issue [10,11].

Screw loosening can also be caused by other variables such as operator error, torsion relaxation, and heat changes [11]. Furthermore, ridge resorption, implant length and quantity, opposing dentition, implant angulations, and parafunctional behaviors may all raise the risk of complications [12]. Implants supporting or retaining an overdenture in a severely resorbed mandible may be subjected to excessive masticatory stresses from the mesial and distal cantilever, as well as the occlusogingival lever arm. Off-axis centric contacts, excursive contacts, cantilevered loading, and internal stresses caused by component and framework mismatch are over these forces [10]. The occlusal forces generated by angulated implants may be greater than the screw can withstand [10,13].

Prosthesis fracture, acrylic resin failure, or wear may occur in addition to implant fracture. When the applied loads surpass the material's proportional limit or fracture strength [14], such difficulties occur. Other technical issues, including material contamination, casting porosities, and poor alloy-surface preparation, can cause prosthetic difficulties [12].

Misalignment of the framework has also been considered as a contributing factor in prosthetic

failures [15]. It is important to remember that an exact passive fit of a framework is nearly unattainable. However, research that aimed at determining the impact of the degree of misfit of an implant-supported or implant-retained restoration on the implant bone-phase boundary has failed to show that misfit has a deleterious impact on this location [12].

This study aimed to estimate the prosthetic and biological complications of the fixed screw-retained hybrid prostheses versus implant-supported mandibular overdentures.

Patients and methods

Patients

The study design was a randomized controlled clinical trial conducted on 22 male patients selected from the Outpatient Clinic of Prosthodontic Department, Faculty of Oral & Dental Medicine, Badr University, Egypt. The participants were selected according to strict inclusion and exclusion criteria. The inclusion criteria included middle-age range (45–70 years old), the edentulous ridges covered by healthy mucosa, acceptable bone status verified by preliminary cone-beam computed tomography, adequate interarch space to accommodate maxillary and mandibular implant prostheses, normal maxillary-mandibular relationship angle class I, and finally good physical and mental health to give informed consent. The exclusion criteria were female patients, uncontrolled diabetes, smoking habits, radiotherapy, clinical or radiographic signs of pathologic conditions, osteoporosis, patients on corticosteroids, and bruxism. Only motivated patients were enrolled in the study after signing informed detailed consent.

The planning of the implants' locations and angulations was done using the radiographic stent that was scanned twice using cone-beam computed tomography (i-CAT Vision; Imaging Sciences International, Hatfield, Pennsylvania, USA). Both images were blended using three-dimensional image-based software (OnDemand 3D App Software; CyberMed Inc., South Korea) to obtain a three-dimensional tissue-supported CAD/CAM-printed surgical guide.

Ethical approval

The present study was conducted with the Code of Ethics of the World Medical Association, according to the principles expressed in the Declaration of Helsinki. This study has been approved by the local Ethics

Committee of National Research Center with approval number 20199, in addition, a written informed consent was provided by each participant prior to their inclusion in the study.

Sample-size calculation

The sample size was calculated, depending on a study of independent cases and controls with one control(s) per case in the previous study of Kortam and Abdeen [16]. Prior data indicated that the probability of exposure over controls is 0.5. If the true probability of exposure over cases is 0.001, we need to study 11 case patients and 11 control patients to be able to reject the null hypothesis that the exposure rates for cases and controls are equal with probability (power) 0.8. The type-I error probability associated with this test of this null hypothesis is 0.05. An uncorrected χ^2 statistic was used to evaluate this null hypothesis.

Study design

They were randomly categorized into two groups as follows:

Group I (control group): the patients received four implant-retained mandibular overdentures.

Group II (experimental group): patients received fixed screw-retained mandibular hybrid prosthesis retained by six implants.

Methods

Surgical methods

The patient was instructed to rinse an antiseptic mouthwash three times daily before the surgery by 2 days and before the surgery by 1 h. A prophylactic dose of 1000 mg of amoxicillin was prescribed for the patient 1 h before the surgery and 3 days after surgery. Implants were inserted according to study-design criteria (Dentis Co. Ltd, South Korea).

The surgical procedures were carried out on one visit for each patient. Bilateral alveolar nerve-block anesthesia for the mandibular jaws. The surgical guide was checked and corrected if needed, the implants were installed in the previously planned sites, and healing abutments were placed at the time of surgery.

The definitive prosthesis fabrication started after 3 months of healing, the surgical stent was used to reposition the location of the implants after the patient was anesthetized. The implants were uncovered using tissue punch. Impression copings were attached to the implants to make an open-tray

impression for the mandibular ridge, and in the dental laboratory, the analogs were connected to the copings, and the impression was poured to get the master cast.

Prosthetic methods

New maxillary and mandibular complete dentures were fabricated using custom impression trays and elastomeric final impressions. The jaw-relationship records were obtained using record bases with wax-occlusion rims. Esthetic tooth evaluation was completed to obtain patient approval. The lingualized occlusal concept was adopted.

Autopolymerizing acrylic resin was used for duplicating the dentures to obtain radiopaque stents, the acrylic resin powder was properly mixed with barium sulfate powder in a ratio of 3 : 1. Small holes were done (~1 mm in diameter) in the central position of each tooth. The templates were placed intraorally and the patient was instructed to bite in centric relation, on a mix of putty silicone impression material. For group I, the metal copings were fabricated to support the overdenture, and for group II, the metallic framework was fabricated to be connected to the installed implants.

Occlusion blocks were constructed to record a new jaw-relation record. The occlusal plane was adjusted intraorally using a bite fork for occlusal alignment and the maxillary cast was mounted on a semiadjustable articulator (Bio-art semi-adjustable articulator; A7 Plus, Brazil) using maxillary face-bow transfer (Bio-art face bow, Brazil), while the lower cast was mounted using centric relation record following check-bite technique at the predetermined VDO. The protrusive record was done following the wax-wafer technique to modify the horizontal guidance of the articulator. The articulator with the mounted casts was sent to the lab for the artificial teeth setup.

Semi-anatomic teeth with 20° cusp angulation were chosen for mandibular posterior teeth, they were set according to the lingualized occlusion concept. After the setup of the teeth was done, a try-in visit was done to confirm the centric relation and vertical dimension of the patient. For group I, the overdenture was processed, finished and polished, and fitted onto the telescopic abutments (Fig. 1), on the other hand, for group II, the hybrid prosthesis was screwed to the implants using the screwdriver and the holes opposing the screw heads were covered by pink composite (Fig. 2).

Follow-up

Maintenance and evaluation of the delivered prostheses were done in the Medical and Scientific Centre of Excellence, Oral and Dental Research Institute. The assessment for the mandibular prostheses was done in both groups according to scheduled visits after 1, 3, and 6 months of prostheses delivery, as a certain list was followed and checked:

- (1) Prosthetic complications (screw loosening, screw fracture, tooth wear, and tooth separation).
- (2) Biological complications (Implant loosening, Peri-implant mucositis, Denture relining).

Figure 1.



The fitting surface of the telescopic implant overdenture (group I).

Statistical analysis

Statistical analysis of the given data was performed using IBM SPSS software package, version 20.0 (IBM Corp., Armonk, New York, USA) and Graph Pad Prism. Data revealed as counts and percentages for each output of biological and prosthetic complications over 6-month follow-up periods. Studying the effect of time (1, 3, and 6 months) on each group and comparison between group I and group II were performed using χ^2 test for significance evaluation.

Results

For the effect of time on biological complications, implant loosening revealed the highest percentage after 1 month (14.29%) in both groups. Peri-implant mucositis revealed the highest percentage after 6 months in group II (42.86%) and remains stable over 6 months (28.57%) in group I. Denture relining is a biological complication that remains stable over 6 months (0%) in group II, but there was an increase in percentages in group I (42.86%), all listed in Table 1.

While for the effect of time on prosthetic complications, screw loosening revealed the highest percentage after 6 months (28.57%) in group II and after 6 months (42.86%) in group I. Regarding screw fracture, it revealed a high percentage (14.29%) after 3 months in group II and (14.29%) after 6 months in group I. Tooth wear revealed a higher percentage (85.71%) in group II after 6 months and (28.57%)

Figure 2.



Occlusal view of the screw-retained fixed prosthesis (group II). (a) Final insertion of screw-retained fixed prosthesis. (b) Trial insertion of screw-retained fixed metal framework.

Table 1. Distribution of biological complications of group I and group II over a 6-month follow-up period

	Telescopic overdenture (group I) [n (%)]	Hybrid fixed screw retained (group II) [n (%)]	
Implant loosening, 1 month	2 (14.29)	2 (14.29)	1.000
3 months	0	0	–
6 months	0	0	–
<i>P</i> value	0.2037	0.2037	
Peri-implant mucositis, 1 month	3 (28.57)	5 (42.86)	0.4944
3 months	3 (28.57)	3 (28.57)	1.000
6 months	3 (28.57)	5 (42.86)	0.4944
<i>P</i> value	1.000	0.4944	
Denture relining, 1 month	0	0	–
3 months	2 (14.29)	0	0.2037
6 months	5 (42.86)	0	0.0167*
<i>P</i> value	0.1473	–	

*Significant difference at *P* value less than 0.05, using χ^2 test.

Table 2. Distribution of prosthetic complications of group I and group II over a 6-month follow-up period

	Telescopic overdenture (group I) [n (%)]	Hybrid fixed screw retained (group II) [n (%)]	<i>P</i> value
Screw loosening, 1 month	0	2 (14.29)	0.2027
3 months	2 (14.29)	3 (28.57)	0.4252
6 months	5 (42.86)	3 (28.57)	0.4944
<i>P</i> value	0.0167*	0.4252	
Screw fracture, 1 month	0	0	–
3 months	0	2 (14.29)	0.2037
6 months	2 (14.29)	0	0.2037
<i>P</i> value	0.2037	0.2037	
Tooth wear, 1 month	2 (14.29)	2 (14.29)	1.000
3 months	3 (28.57)	5 (42.86)	0.4944
6 months	2 (14.29)	9 (85.71)	0.0011*
<i>P</i> value	0.4252	0.0011*	
Tooth separation, 1 month	2 (14.29)	2 (14.29)	1.000
3 months	0	3 (28.57)	0.0614
6 months	2 (14.29)	8 (71.43)	0.0082*
<i>P</i> value	0.2037	0.0082*	

*Significant difference at *P* value less than 0.05, using χ^2 test.

in group I after 3 months. Finally, tooth separation revealed a higher percentage (71.43%) in group II after 6 months and (14.29%) in group I after 1 and 6 months, as listed in Table 2.

Performing the χ^2 test for significance evaluation of the effect of time on biological complications, there was an insignificant difference between different time intervals for both groups as *P* value more than 0.05. While for significance evaluation of the effect of time on prosthetic complications, there was a significant difference of screw loosening in group (I), tooth wear, and tooth separation in group (II) as *P* value less than 0.05.

In addition, a χ^2 test was performed for significance evaluation between both groups in biological and prosthetic complications. In biological complications, it revealed a significant difference in relining after 6

months between both groups as *P* value less than 0.05. While for prosthetic complications, there was a significant difference between both groups in tooth wear and tooth separation after 6 months as *P* value less than 0.05.

Discussion

It has been revealed that most of the problems of the implant-retained prosthesis between the first and sixth week postinsertion are directly related to the occlusion. Generally, in this research over a 6-month follow-up period, all complications of implant-retained mandibular prosthesis opposing plain maxillary complete denture, it could be said that forces exerted by specific occlusal schemes were within the physiological limits of the bone supporting the implants [17].

In the edentulous mandible, the probability of implant loss was substantially higher. When comparing the number of implants in the mandible, higher numbers had a definite tendency to result in lower implant-loss rates. This concept's current results are based on past studies [17] and show a 5-year survival rate of 92.1%, which is satisfactory. Nonetheless, implant-loss rates for two and four implants with an overdenture were much lower, with data based on 11 different patient groups. The 'gold-standard concept' of two implants with an overdenture appears to be unconfirmed by this study, at least when it comes to postloading implant survival [17].

The increased peri-implant mucositis in the fixed-prosthesis group than the removable-prosthesis group may be attributed to the proximity and increased number of the implants to each other, which facilitate plaque accumulation, complicate oral hygiene practice, and induce peri-implant mucosal inflammation. The decreased manual dexterity of the patients and the inability to clean the area between the implants could be responsible for this significant increase of peri-implant mucositis in the fixed-prosthesis group. A similar observation was reported in another study, which also reported that participants faced difficulty in performing good oral hygiene in the fixed-prosthesis group compared with the removable-prosthesis group [18].

In this study, 57.15% of removable-prosthesis cases showed higher bone resorption compared with fixed-prosthesis cases (the need of relining), however, the difference was not significant along the 6-month follow-up. This finding agreed with the results of a systematic review, which reported that marginal bone-loss values beneath denture bases of removable overdentures, were significantly clear. This could be attributed to increased loads of denture bases around the implant compared with the fixed-prosthesis group due to the larger-fitting surface area of the removable prosthesis [19].

It was found that stresses at the bone/implant interfaces on the loaded sides were the highest at the most distal bone/implant interface and that stresses rose dramatically with cantilever length following the lingualized concept of occlusion. Moreover, the anterior-posterior spread was enhanced by using tilted implants, splinting the implants with a rigid superstructure as denture base of telescopic denture might induce a high incidence of screw loosening [20].

In an attempt to discover trends in the occurrence of screw-fracture data from other studies, because of the

large variation in the number of implants with fixed and removable prostheses evaluated and the lack of statistical analysis, the authors clarified that the mean percentages presented in their study suggested trends rather than absolute incidence values and should be interpreted with caution due to exclusion of patients' bruxism cases [21].

Chewing forces are indisputably conveyed to the restoration, and these forces are distributed throughout the restoration-implant complex. The energy of the chewing force could be transferred to the restorative materials, abutment, screws, implants, and peri-implant bone. Several studies have emphasized that the usage of rigid materials supported by removable denture bases could result in a better distribution of stresses diminishing tooth surface wear. However, in our investigation, the use of acrylic in combination with the metal framework exhibited relatively modest stresses in the bone concentrated around the implant when compared with the removable one compensated by tooth surface wear [22].

Tooth debonding was relatively common in fixed hybrid implant-retained prostheses. Debonding rate was 1.08% (95% confidence interval: 0.15–2.58%) per year, and the total estimated 3- and 5-year debonding rates were 3.2% (95% confidence interval: 0.4–7.4%) and 5.3% (95% confidence interval: 0.7–12.1%), respectively. The incidence of debonding was further investigated based on framework-bonding protocols. For the fixed hybrid implant-retained prosthesis, 71.43% debonding occurred during the follow-up time. Regarding the removable-prosthesis group, only 14.29% of cases of debonding occurred, which was significantly lower than that of the fixed hybrid implant-retained prosthesis [21].

Conclusions

Under the limitations of this study, we have concluded that both treatment modalities telescopic implant overdenture and hybrid fixed screw-retained are reliable for restoring the completely edentulous arches. Regarding prosthetic complications, telescopic overdenture showed a higher incidence than hybrid fixed screw-retained of screw loosening and screw fracture. While regarding biological complications, telescopic overdenture showed the same incidence as hybrid fixed screw-retained implant loosening with a higher incidence of denture relining and lower incidence in peri-implant mucositis. However, more longitudinal studies

should be established to study the possible complications and maintenance means of implant prostheses to help clinicians to formulate the best treatment plans for edentulous patients.

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Conflicts of interest

There was no conflicts of interest.

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