ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
March 2021 • Vol. XXIV

EFFECT OF DIFFERENT ARTIFICIAL TEETH MATERIALS ON THE SUPPORTING STRUCTURE OF MANDIBULAR IMPLANT RETAINED OVERDENTURE

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Abstract

Aim: The purpose of this study was to evaluate radiographically the effect of using (Nano-hybrid composite resin teeth and Cross linked acrylic denture teeth) materials on marginal bone height changes around implant retained mandibular overdenture using digital radiography (digora). A comparative study.

Materials and Methods: Twelve completely edentulous patients were randomly divided into two groups according to the artificial teeth material used in complete denture. One group received complete dentures with cross-linked acrylic resin teeth and the other group received complete dentures with Nano-hybrid composite teeth. Digital radioghraph was taken at the delivery, 6 months and 12 months follow -up appointments. The evaluation was done for marginal bone height changes around implants.

Results: Analysis was done by using two-tailed t-test revealed that increase in amount of bone loss in both groups which is in favor to patients wearing dentures with Nano-hybrid composite resin teeth.

Conclusion: Nano composite resin teeth materials compared favorably to acrylic resin teeth materials on the supporting structures of implant retained mandibular overdentures.

Key words: Implant overdenture-Teeth materials- Nano composite - Acrylic resin teeth

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Introduction:

Complete removable dentures are one of the challenges in dentistry as how to satisfy all functional and esthetic requirements of patients. Conventional complete denture wearers complain mainly from instability of their mandibular dentures, inability of mastication, decrease quality of life and satisfaction. (1) Using implants to decrease progressive ridge resorption, thus implant retained overdentures used to improve denture retention, stability, patient's satisfaction and quality of life. (2)

Implant overdentures are an excellent option to fixed implant-supported prosthesis because of their inexpensive cost and clinical need in circumstances when inserting many implants in the arch with the proper number and arrangement to support a fixed prosthesis is problematic. Because they are removable and supported by a smaller number of implants, they are also easier to clean. It helps to support the face profile by the denter flanges which is a great advantage over a fixed prosthesis. (3-4)

Placement of implants in the interforaminal region achieved great improvements in masticatory function, speech, quality of life and nutrition. Using ball attachments to retain overdenture increase patients comfort than with complete dentures. (5, 6)

Because there are so many artificial teeth materials, constructing a removable prosthesis necessitates the selection of denture teeth with superior properties. It is also used to restore the form, function, and aesthetics of fully and partially edentulous patients by selecting teeth that improve the quality of mastication, esthetics and speech. (7)

Acrylic, porcelain, and composite teeth are routinely used in modern prosthodontics for denture manufacture, each having its own set of benefits and drawbacks. Denture teeth made of porcelain were the first to be used in dentistry. Despite their higher wear resistance, they have a number of significant drawbacks, including lack of bonding to the denture base, brittleness, and extreme hardness. (8)

The first acrylic teeth appeared in the 1930s, with polymethylmethacrylate (PMMA) being the most popular. PMMA made up nearly 98 percent of all acrylic denture teeth by 1950. It addressed some of the issues with porcelain denture teeth, such as brittleness, ease of shaping custom anatomical forms, and chemical bonding to the denture base; however, excessive wear remained a key worry, as acrylic denture teeth are brittle so the occlusal morphology of acrylic denture teeth can change rapidly in a short period of time. (9)

It's commonly constructed of PMMA resin, which is very elastic and has an excellent chemical bond with the denture base. High fracture toughness, quiet on contact, cold flow under stress, and minimal abrasion of the opposing dentition are only a few of the benefits of acrylic resin teeth. Acrylic teeth are less prone to fracture than porcelain teeth, have less clicking, bond easily to the denture base, are easier to grind, recontouring, and repolishing, and are more compatible with the acrylic denture base. (10, 11)

There are some drawbacks of acrylic resin teeth, such as low thermal conductivity, surface micro-porosity, and low wear resistance which has been found to be lower than that of ceramic teeth. Excessive wear has many consequences; it causes loss of vertical dimension of occlusion, loss of masticatory efficiency, faulty teeth relationships, and masticatory muscles fatigue. (12)

Nano-composite resin materials, which are made up of a homogeneous urethane organic matrix reinforced by heterogeneous silica fillers, are a recent development in the field of denture teeth materials. Traditional

macro and micro filled composites are less polishable, stain resistant, and impact resistant than nano hybrid materials. Denture teeth with outstanding qualities must be chosen when fabricating a removable prosthesis. Wear resistance is one of the most significant physical features for maintaining the optimum occlusal vertical dimension and chewing efficiency. [13, 14]

In vitro testing revealed that hybrid (particularly nano-filled) resin composites outperform traditional composites and acrylic resins in terms of surface smoothness and stain resistance. The esthetic features of the filler were found to improve as the particle size of the filler was lowered. [15]

Teeth made of conventional and cross-linked acrylic resin have less wear resistance than teeth made of micro- or nano-filled composite resin, as well as human enamel. [16]

In a vivo study nano-hybrid composite teeth are hypothesized that it transmit more occlusal force to the residual alveolar ridge than acrylic resin teeth. So this study was undertaken in order to compare radiographically the effect of nano hybrid composite and acrylic resin denture teeth materials on the supporting structures (bone height changes around implants) in totally edentulous patients. [16]

Materials and Methods:

Twelve completely edentulous patients shared in this study, with the following criteria:

- Completely edentulous upper and lower arches.
- Age ranged from 50-70 years.
- Free from systemic diseases affecting bone remodeling..
- Patients with no history of radiotherapy or chemotherapy.
- Free from para-functional habits and TMJ disorders.
- Patients had good oral hygiene and motivation to be part of the study.
- Exhibited Angle's class I maxillo-mandibular skeletal relation.
- The residual ridges had adequate height and width and covered by firm dense mucoperiosteum.
- Smokers were excluded.

All patients were rehabilitated with upper and lower complete dentures before implant insertion following the conventional technique: Upper and lower primary impressions were made using Alginate impression material (Cavex alginate, Cavex, Holland) in properly selected stock trays. The impressions were poured in dental stone (Lab stone, Miles dental Product, Miles, INC, South Blend, USA.) to obtain study casts and self-cure acrylic resin (Pekatray, Bayer. Dental, Lever Kusen, Germany) was used for construction of special trays. Secondary impressions were made using green stick compound (Hiflex Thermoplastic impression green sticks, Prevest Denpro, India.) for border tracing and zinc oxide-eugenol impression material (Zinc Oxide Eugenol, Cavex, Holland Bv). The impressions were poured in dental stone to obtain the master casts, upon which upper and lower occlusion blocks were fabricated. A face bow record (Denatus facebow. Type AFB. Jakobsdal. Svagen 14-16. S12653, Hagersten. Sweden) was made to mount the maxillary cast on a semi adjustable articulator (Denatus articulator Type ARH. Jakobsdal. Svagen 14-16. S12653, Hagersten. Sweden) Centric occluding relation record was made to mount the mandibular cast following the wax wafer technique (Base plate Modeling wax, Cavex, Holland BV) then patients were divided into two groups.

I-Patients grouping:

After registration of jaw relation records, patients were randomly divided into two equal groups according to the material of artificial teeth used in denture construction into:

Group I: Patients in this group were rehabilitated by implant retained mandibular overdentures having cross linked acrylic artificial teeth (NT Unay acrylic resin teeth, Toros Dental, Turkey).

Group II: Patients in this group were rehabilitated by implant retained mandibular overdentures having nano hybrid composite artificial teeth (SR Phonares II *Typ*, Ivoclar Vivadent)

The lingualized concept of occlusion was used in both groups to set up the teeth. The waxed-up dentures were tried in the patient's mouth to ensure adequate face contour, extension, stability, accurate vertical dimension, centric occlusion and centric relation harmony. The waxed-up maxillary and mandibular dentures were flasked, then processed into heat-cure acrylic resin before being remounted in the lab. After clinical remounting, the dentures were polished and finished before being supplied to patients with post-insertion instructions. Patients were then recalled for implant insertion procedure.

II-Implant placement:

Two conventional implants screw type with 3.7 mm diameter and 13 mm length were used for each patient.

Patients were instructed for pre-surgical medication; Oraldene mouth wash was prescribed three times per day one week before surgery and continued for another week, Augmentin 1 gm one tablet every 12 hours was prescribed 24 hours before the day of surgery and continued for 5 days after surgery. Starting at the day of the surgery, Alphintern was prescribed three times per day for 4 days as an anti-inflammatory agent and Cataflam 50 mg was prescribed as an analgesic when needed.

Mandibular denture was duplicated into clear heat cure acrylic resin with radiopaque markers attached to proposed implant sites (at canine areas) to be used as radiographic stent. Cone Beam computerized tomography (CAT Vision®, PA, USA) was performed to detect proper implant length and width. By attaching metal tubes to canine regions, the radiographic guide was transformed into a surgical guide. A full thickness mucoperiosteal flap was raised after a crestal incision was performed from premolar areas on one side to premolar areas on the opposite side. Two implants (TioLogic, Dentaurum) were placed in the canine locations (first surgical stage). Interrupted sutures were used to seal the mucoperiosteal flap. The occlusion was corrected, and the mandibular dentures were relined with tissue conditioner. Figure (1)

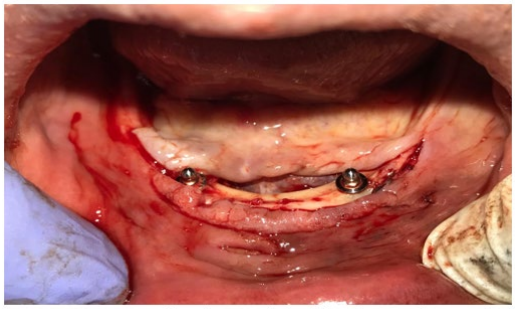

Figure (1): two implants placed in the canine region

III-Implant loading

After three months implant loading was done (second surgical stage). Opening over the implants was done and the two ball attachments are screwed into the implants and an elastomeric block-out shim (blockout shims, 3M ESPE, Germany) was placed over the implants head then the metal housings were placed.

The denture was then seated on the metal housings containing O ring attachments and adjustments were done till complete seating of the denture while the patient was biting in centric occluding relation. Any interference was detected by pressure indicating paste and then removed.

In the relived areas of the lower denture, self-cure acrylic resin was prepared and applied.The denture was inserted in the patient's mouth while the patient bit in

centric occlusion until the pick-up material polymerized completely.

The follow up radiographs were recorded throughout time, from the time of implant loading to 6 months, 6 months to 12 months, and 12 months to the time of implant loading. Figure (2)

(A) (B)

Figure (2): (A) Complete denture with acrylic resin teeth in place.
(B) Complete denture with Nano-hybrid composite teeth in place.

IV-Statistical analysis:

All of the information was gathered and tabulated. IBM® SPSS® Statistics Version 20 for Windows was used to conduct the statistical analysis**.** Checking the data distribution, calculating the mean and median values, analysing histograms and normality curves, and employing the Kolmogorov-Smirnov and Shapiro-Wilk tests were all used to investigate the normality of numerical data**.** The data were given as mean, standard deviation (Std.), T test for comparison between groups, Paired t test for comparison between follow-up periods within groups, and $P \leq 0.05$ for significance.

Results:

Effect of different teeth materials on rate of bone resorption around implants: During the follow-up period, the average value of marginal bone height loss surrounding implants for group (I) and (II) are displayed: From loading time to 6 months, the mean marginal bone loss around implants was.466 mm ± .058 for group I (acrylic) and.3009 mm ± .052 for group II (Nano hybrid composite). P≤ 0.05 indicated that the difference between the two groups was statistically significant.

From 6 to 12 months, the mean marginal bone loss around implants was.425 mm ± .129 for group I (acrylic) and .224 mm ± .0309 for group II (Nano hybrid composite). P≤ 0.05indicated that the difference between the two groups was statistically significant. From time of loading to12 months, the mean marginal bone loss around implants was .891 mm ± .125 for group I (acrylic) and .525 mm ± .056 for group II (Nano hybrid composite). P≤0.05 indicated that the difference between the two groups was statistically significant.

Group I showed more bone loss around implants than in group II and the difference was statistically significant through the follow up periods.

Table (1): Statistical analysis showing the difference in bone height loss in acrylic resin teeth group (Group I) versus nano composite resin teeth group (Group II) during the follow up intervals.

Interval	Group	Mean	Std.	P
loading to 6 months	Group I	.4662	.05855	<0.001*
	Group II	.3009	.05209	
6 to 12 months	Group I	.4256	.12939	<0.001*
	Group II	.2248	.03097	
loading to 12 months	Group I	.8919	.12508	<0.001*
	Group II	.5257	.05661	

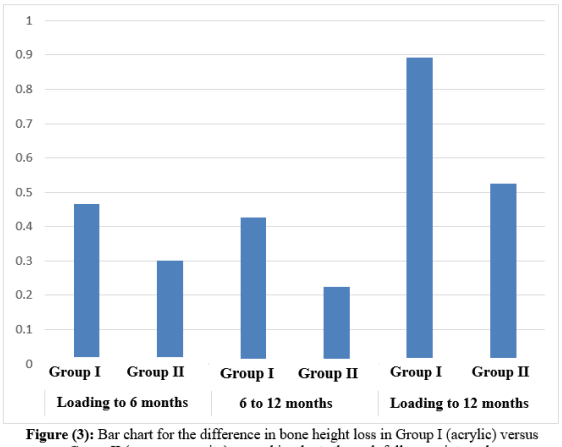

Figure (3): Bar chart for the difference in bone height loss in Group I (acrylic) versus Group II (nano composite) around implants through follow up intervals

Discussion:

The use of implants to retain and support complete mandibular over-dentures has helped to fulfill the functional requirements of most edentulous patients. Implant-retained mandibular over-dentures present a reliable and simple solution for denture retention and stability problems. (17)

The superstructure occlusal material is one of the factors that play an important role in the long term survival of

dental implants. Resilient superstructure material (acrylic resin and composite resins) would be useful at reducing stresses around the implant by the materials' elastic deformation behaviors. [18]

In this study, nanocomposite resin teeth material was selected to be compared to acrylic resin teeth material; they are both resins with low modulus of elasticity as it was hypothesized that an occlusal material with a low modulus might decrease the occlusal impact forces, thereby decreasing its effect on the bone-implant interface. [19, 20]

The teeth were set up using the lingualized concept of occlussion, which has various advantages, including greater cross-arch balance, improved denture stability, and increased patient comfort. Because the maxillary palatal cusps are the only point of contact with the mandibular posterior teeth at their central fossae, lateral forces were minimized. As a result, potentially harmful lateral forces were reduced to a minimum. The mandibular residual ridges could be the focus of vertical stresses. The use of vertical forces was thought to be beneficial for denture stability and the preservation of the supporting hard and soft tissues. [20]

Direct digital radiography was used as a method of radiographic evaluation to analyze the marginal bone height changes around the implants as it offers instant images with lower patient radiation exposure than the conventional panoramic radiography. It also avoids variations in the images density and contrast due to chemical processing as it implies a standardized dry processing. [21]

Reduction of implant marginal bone level was observed in both groups all over the study periods and at the same time the mean values of bone loss were in agreement with the success criteria within the permissible range previously reported to happen within the first year of implant placement. [22]

The results of this study revealed a decrease in crestal bone height around implants for the two groups throughout the study periods. The mean crestal bone loss in this study for Group I (cross-linked acrylic teeth group) was 0.891 mm and for Group II (nanocomposite resin teeth group) was 0.525 mm after the follow up period. This may be due to bone reaction after loading of the prosthesis at first and further reduction of bone height till the end of the study period (one year) might be due to mechanical factors acting on the implants; loading and forces of mastication. [22]

The results of bone height measurements around implants revealed that there is a difference between the two studied groups and that the difference was statistically significant. As the difference in bone loss may be attributed to many biomechanical factors as occlusal teeth form, length, width of occlusal table, type of teeth material and theory of occlusion being followed, also as the processing technique significantly increased the elastic modulus of artificial denture teeth here in this study all these factors were standardized between the two studied groups except the type of teeth material, thus the resulted difference in bone loss is due to that factor only. [23, 24, 25]

This study showed that the type of occlusal material does in fact have a direct influence on the bone surrounding implants. Ciftci and Canay [26] support this finding as they reported that the intensity of the resulting stresses around an implant would be due to the physical qualities of the occlusal material used. Therefore the type of the occlusal material can be considered an important factor in conducting the stresses generated by static or impact forces to the lower supporting structures. This finding is in agreement with the findings of Davis et al

[27], Papavasilliou et al [28], and Misch and Bidez [29]

Nano composite resin teeth seemed to be more suitable for complete and partial dentures because of their good wear resistance. In addition, they consist of a newly designed nano-hybrid composite material, whose resistance to discoloration is significantly increased over that of conventional composite materials. [30]

On the other hand, this is on the contrary of the findings of Ismail et al [31], Stegaroiu et al [32] and Wang et al [33]who stated that the type of occlusal material has insignificant effect on the stresses at the bone implant interface. This controversy may be due to the nature of their studies that were based on in vitro work while this study is based on clinical work and that the clinical situation includes many different affecting factors.

The question now is why bone loss was higher in group I (cross-linked acrylic teeth) than in group II (nano composite resin teeth). This could be due to the difference in wear resistance between acrylic and nano composite resin teeth, with acrylic teeth wearing out faster. [33, 34] These findings backed with M Abdallah et al's [35] concluded that nano composite teeth are more wear resistant than traditional acrylic teeth.

Wear of artificial teeth is a source of concern for both the patient and the prosthodontist because it results in a loss of vertical dimension, masticatory efficiency, a faulty teeth relationship, and increased horizontal stress, all of which have negative consequences. The lack of vertical occlusion produces higher pressures on the anterior alveolar ridge, which raises the rate of residual ridge resorption, results in loss of anterior alveolar ridge height, and degrades esthetics. [35]

The theory of wear can explain the results of this study in such a way that acrylic teeth may be worn than composite teeth and this led to loss of occlusal contacts preserving the occlusal balance leading to premature contacts with more stresses produced and also loss of vertical dimension may lead to contacts between the teeth anteriorly which increase the stresses on the anterior segment of the arch including the mini-implants and the surrounding bone. Although acrylic teeth are more resilient with low modulus of elasticity, they absorb the stresses and protect the underlying tissues. The effect of wear and subsequently the change of force distribution anteriorly and posteriorly was more than the resiliency of the material which resulted in more stresses and more bone loss. On the other hand, the composite teeth have higher modulus of elasticity and are less resilient than acrylic teeth in addition they are more wear resistant thus they can maintain the occlusal scheme and the vertical dimension leading to less stresses and more favorable results.[23]

Such radiographic findings imply that composite resin as an occlusal material, transmits occlusal forces more favorably to implants and their supporting bone than acrylic resin and they may be a better alternative as an occlusal material for implant retained prosthesis in the anterior area of the mandible.

Conclusion

According to the findings of this study, changing the type of artificial teeth material has an impact on the marginal bone height around implants.

On the supporting structures of implant retained mandibular overdentures, nano hybrid composite resin teeth materials outperformed acrylic resin teeth materials.

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