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Original Article

Evaluation of the Marginal Bone changes around Implants placed in Mandibular Class I Kennedy Patients with Sleep-Related Bruxism using 3D-Printed versus Conventional Occlusal Stabilization Splints

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ABSTRACT

Aim: This Randomized Double-Blinded Control Clinical Trial aims to assess the effect of 3D Printed Digital versus Acrylic Resin Conventional Occlusal Stabilization Splints on the Marginal Bone height around Implants installed in Mandibular Class I Kennedy Patients diagnosed with Sleep-Related Bruxism.

Material and Methods: Twelve patients were examined and diagnosed with sleep-related bruxism and with unmodified mandibular Kennedy Class I was recruited in this study. For each patient, three implants were placed bilaterally in the premolar/molar mandibular region. Patients were divided into two groups: *Group I (Six patients)* received 3D Printed Digital occlusal stabilization splints and *Group II (Six patients)* received the conventional acrylic stabilization splints on the day of restoration insertion. Cone beam computed tomography (CBCT) was used to examine the radiographic assessment at 0, 3, and 6 months after surgery.

Results: This study showed a non-statistically significant difference in bone height in the two groups ($P > 0.05$) throughout the whole study period.

Conclusion: Both the 3D Printed Digital Splints and the Conventional Acrylic Stabilization Splints showed reliable results on bone height changes around implants and either types should be advised to be worn for protecting the underlying fixed implant prosthesis and supporting structures in patients diagnosed with sleep related bruxism.

Keywords: Occlusal appliance, Night guard, Digital dentistry, 3D printing.

INTRODUCTION

Bruxism is defined as an oral dysfunction, characterized by teeth grinding or clenching during sleep. Long-term continuous night bruxism can cause temporomandibular joint dysfunction, tooth wear, and occlusal trauma. [1]. Studies have demonstrated that bruxism is caused by a variety of factors including physical and psychological status even though the pathophysiology of bruxism is not yet fully understood. [2]. There are articles in the literature that the incidence of bruxism is as high as 12.8% of the population [3]. Since Occlusal stabilization can improve the asymmetry of the masseter and temporalis muscles, and reduce the forces exerted on the temporomandibular joint

and other structures of the masticatory system while dispersing the occlusal force and reducing teeth attrition [3,5], fabrication of occlusal stabilization splint is one of the current standard treatments for bruxism [6].

Oral Occlusal Stabilization splints are universally fabricated from Polymethylmethacrylate (PMMA) in a manual labor-intensive workflow (powder-liquid technique) necessitating time, material, and personnel.[7] Nowadays, digitalization permits machine-based manufacturing in either a milled (subtractive) or a printed (additive) means using industrial-made PMMA or comparable resins. In recent years, digital technology has changed rapidly, and computer-aided design (CAD) and computer-aided manufacturing (CAM) has become more and more widely used in the field of dental prosthetics [8, 9].

For dental implants to be clinically successful, a direct bond between dental implants and bone is necessary to be formed without the need for intervention of soft tissues, a process called "osseointegration". Despite the high success rates (10), difficulties associated with implant treatment may occur such as early loading failure which may affect 2% to 6% of implants, and as many as 15% of restorations fail as a result of this problem(11). Excessive load on oral restorations after successful implant osseointegration due to para-functional habits such as grinding, or clenching can fail the implant itself. (11)

To gauge the impact of the occlusion scheme and its connection to nocturnal bruxism, a night guard can be a valuable tool. (12) Fixed and removable implant prostheses' occlusal plans and designs must adhere to the standards for safe vertical loading of dental implants). Parafunctional habits (clenching or grinding) can transmit forces to the supporting bone beneath, which could lead to damaging lateral strains and overloading. Night guards made of acrylic resin may be able to mitigate the effects of nocturnal parafunctional behaviors (13). The pressures associated with nocturnal teeth clenching and grinding are appropriately distributed and vertically redirected by a rigid stabilizing splint worn at night (night guard). (14)

Since most of the clinical research in dental implants excluded subjects with bruxism, there are only a few research data on the influence of bruxism on dental implant outcome, and there is still no scientific evidence for a causal relation between bruxism and implant failure [15]. The purpose of this Randomized Double-Blinded Control Clinical Trial is to evaluate the effect of 3D Printed Digital versus Acrylic Resin Conventional Occlusal Stabilization Splints on the Marginal Bone Height around dental Implants placed in Mandibular Class I Kennedy Patients diagnosed with Sleep-Related Bruxism. This study will also present the complete digital workflow using a free software program and a low-cost 3D printer to fabricate occlusal stabilization splints for managing patients diagnosed with Sleep-Related Bruxism.

MATERIALS and METHODS

Sample Size calculation:

The target populations in this study were Mandibular Class I Kennedy Classification Patients diagnosed with Sleep-Related Bruxism. The sample size was calculated depending on a study of independent cases and controls as reported in a previous study performed by Velasco-Ortega et al. (16). Prior research showed that among controls, the incidence of exposure is (0.5). In order to have sufficient power to reject the null hypothesis that the exposure rates for cases and controls are equal with probability, we must examine 6 case patients and 6 control patients if the true probability of exposure among cases is (0.001) (0.8). The test of this null hypothesis has a Type I error probability of 0.05. To assess this null hypothesis, an uncorrected chi-squared statistic was employed.

Twelve patients were examined and selected from the outpatient Prosthodontics Clinic, Faculty of Oral and Dental Medicine, Cairo University. Patients were selected with the following inclusion criteria; unmodified Class I Kennedy mandibular arch, showing the normal maxillo-mandibular relationship (Class I Angle classification), 40-60 years of age, and free from any Systemic Disease. The opposing maxillary arch was completely dentulous either by a complete set of natural dentition or restored with satisfactorily fixed restorations. Patient's self-report and/or bed partners' report of bruxism (night grinding sound) and/or clenching at night and/or waking up with Masticatory Muscle soreness/tenderness/pain, with evidence of Teeth wear facets and/or attrition were diagnosed with sleep-related Bruxism or clenching and were recruited in this study. Patients involved in this study signed the consent form according to the ethical principles stated in the Helsinki Declaration (https://www. wma.net) indicating their approval, and undergoing surgical procedures of implant placement. Ethical approval was also obtained from the Ethical Approval Committee in the Faculty of Dentistry, Cairo University.

For each patient, three implants were placed bilaterally in the premolar/molar mandibular region. Patients were divided into two groups: *Group I (Six patients)* received 3D Printed Digital occlusal stabilization splints and *Group II (Six patients)* received the conventional acrylic stabilization splints on the day of restoration insertion. All patients were instructed to wear the nightguards at night only or during sleep and not to exceed 8 hours per day wearing their occlusal appliances in both groups.

Implant Installation

The pre-surgical preparation included Construction of standard mandibular acrylic partial dentures that were reproduced into transparent acrylic resin surgical stents and radiographic stents. All patients performed diagnostic preoperative cone beam computerized tomography (CBCT) (Scanora 3D Soredex, Helsinki, Finland) with preoperatively fabricated radiographic stents to evaluate the residual alveolar bone height and width in the posterior edentulous areas at each of the six potential implant sites.

Pre-surgically, the patients were instructed to follow oral hygiene measures and take a prophylactic antibiotic to control the infection. Amoxicillin-clavulanate 625 mg was prescribed 24 hours before the surgery as one tablet every 8 hours, and patients were asked to continue the antibiotic for one week after surgery to guard against any possible infection.

At the time of surgery, the entire surgical armamentarium was autoclaved, and the surgical places as well as the circum-oral tissues were disinfected by wiping them with an antiseptic solution. Bilateral inferior alveolar nerve block anesthesia was given using a 4% articaine anesthetic solution in addition to field block anesthesia (Ubestesin, 3M ESPE, Germany) to diminish the bleeding as much as possible. A full-thickness mucoperiosteal flap was raised after a mid-crestal incision was performed. Two fixation screws (Biomet M Fix, USA) were used to secure the surgical stent in position Pilot, intermediate, and final drills were used to construct osteotomies, and paralleling pins were used to ensure that the implants were parallel (Fig.1). At the Implant sites, sterile saline irrigation was performed following each drill. The implants used in this investigation were Interactive TM implants (Implant Direct Sybron International, CA 91301, USA. The implants were then manually tightened up until resistance was encountered, at which point a ratchet was used to complete the tightening. Using a torque wrench, the main stability of each implant was verified to be 30 Ncm before the stent was removed. The patients were given post-surgical instructions and prescribed Diclofenac Sodium (Voltaren, 75ml oral,

NOVARTIS, Egypt) to relieve discomfort and swelling. It was also advised that patients continue taking the previously prescribed antibiotic for 5-7 days. The following instructions were also given to the patients: a) immediately after surgery, administer cold packs for 10 minutes at intervals of 10 minutes for 3–4 hours. b) Adhere to stringent oral hygiene guidelines. Sutures were placed and the patient's partial dentures were checked for occlusion.

Implant Loading and Prosthetic Delivery

Patients were recalled after 3 months for restoration delivery and loading of the implants. For each patient, bilateral 3-unit fixed/detachable screw-retained restorations were constructed. The metal framework was tried in the patient's mouth (Fig 2a) and the final restorations were delivered to the patients (Fig 2b). The following occlusal protocol was followed; applying Direct occlusal contact of the final restorations with the opposing maxillary teeth, Evenly distributed occlusal contacts and forces, Broad centric occlusion freedom (wide groove and flat fossa), as well as a slight reduction in cusp inclination, particularly the buccal inclines of the mandibular buccal cusps to prevent interference with lateral excursive movements of the mandible.

Patient Grouping:

The subject numbers and Night-guard treatment groups were organized into a password-protected excel sheet that only one dental assistant involved in the study had access to. Patients were randomly divided into two groups to receive mandibular Occlusal Stabilization appliances (Night-guards):

- **Group I** received 3D Printed Digital Mandibular occlusal stabilization splints (Night-guards) to be worn at night only using the following digital workflow: Intraoral scanning of the maxillary and mandibular teeth, using Medit i700 Intraoral Scanner (MEDIT corp. 23 Goryeodae-ro 22 gil, Seongbuk-gu, Seoul, Korea) was performed. Scanning was done sequentially by starting at the occlusal, lingual then buccal surfaces of all teeth followed by a recording of the centric occlusal relation (Bite) to produce a complete intraoral scan. The patient was guided to close in centric relation using a bimanual manipulation technique to seat the condylar disc complex in the antero-superior position in the glenoid fossa. STL files of the 3D maxillary and mandibular digital casts were exported from the I Medit software and imported to the CAD designing free software (Meshmixer; Autodesk, Inc). The digital casts were then duplicated to design the appliance and then the selection of the mandibular duplicated casts was performed. Extrusion of the mandibular surface by 6 mm (direction "normal") was performed. The internal (fitting) surface was also extruded by 0.12 mm (direction "normal"), followed by deleting the internal surface to create tolerance and reduce the need for clinical internal adjustment of the Night-guard. Evaluation and repairing the errors by using the inspector tool was then performed and the Night-guard was then exported as an STL file for 3D printing. Using the Preform software (Formlabs Inc), supports were generated, and the occlusal surface of the device was positioned parallel to the printing surface (0 degrees). The occlusal device was then 3D printed using the SLA 3D Printer (Form2; Formlabs Inc) using biocompatible class II resin (Clear LT; Vertex-Dental B.V.). The printed Night-guard was then placed in an isopropyl alcohol ultrasonic bath for 5 minutes to remove the unpolymerized resin. Final polymerization in an ultraviolet light chamber heated at 80C for 20 minutes (405 nm, 36W) was then performed before removing the supports. Polishing the external surface by using abrasive paper (sequence or roughness 220, 500, and 1200), followed by polishing paste (Universal Polishing Paste; Ivoclar Vivadent AG) was then completed. The final polished occlusal appliance was then delivered to the patient's

mouth to ensure, fit, stability, and adequate retention on the day the Prosthetic implant-supported retained-screw retained prosthesis was delivered (Figure 3a).

- **Group II** received the conventional acrylic stabilization splints to be worn at night only on the day of restoration delivery using the conventional workflow. Adequate maxillary and mandibular Impressions using additional silicon impression material (Gollene Speedex Dental Vertrieb G murrbtt Konster. Germany), followed by a Bite registration using occlusal rims and an interocclusal registration paste (super bite; Harry J. Bosworth Co., Skokie, IL) was obtained from each patient. The patients were guided to close in centric relation using a bimanual manipulation technique to seat the condylar disc complex in the antero-superior position. The lab technician poured the impressions and prepared the models to carefully remove all bubbles, imperfections around the gingival margins, and the interproximal embrasures between teeth and blocked out any undesired undercuts. Waxing-up of the occlusal appliance around the teeth was then done at a thickness of 6mm. Flasking, wax elimination, and clear acrylic mixing (Pattern Resin, GC America), and pressing were then performed in the usual manner followed by processing, finishing, and finally polishing with polishing mops and paste to create a hygienic appliance with a natural-looking luster. Polishing the external surface by using abrasive paper (sequence or roughness 220, 500, and 1200), followed by polishing paste (Universal Polishing Paste; Ivoclar Vivadent AG) was then completed. The final polished occlusal appliance was then checked on the cast to ensure, fit, stability, and adequate retention and delivered to the patient's mouth on the day of Prosthetic implant supported screw retained prosthesis were delivered (Figure 3b).

When the patients had their appliance delivery appointment, the dental assistant working on the case looked up the subject number in the excel sheet and gave out their Night-guards to the dentist performing the delivery. The dentist performing the procedure was double-blinded by not knowing which the conventional group is and which the 3D Printed Digital Night-guard group is because both Night-guards have very similar colors and consistency. The primary provider, who was double-blinded, has the subject identity codes. No one had access to the subjects/patient's information except for the primary provider and faculty involved in the study.

Radiographic Follow-Up

At 0, 3, and 6 months following surgery, radiographic evaluation was carried out using dental computed tomography (CT) (General Electric Co., light speed plus 4-multislice CT equipment, USA). Around each implant, the crestal bone heights were measured to produce four measurements at the mid-distal, mid-mesial, mid-buccal, and mid-lingual positions (Figure 4), to compare the effect of using two different kinds of Occlusal stabilization appliances on the Marginal Bone Height around Implants placed in Mandibular Class I Kennedy Patients diagnosed with Sleep-Related Bruxism.

Statistical analysis

Statistical analysis was performed with SPSS 20®, Graph Pad Prism®, and Microsoft Excel 2016. All data were explored for normality by using Shapiro Wilk and Kolmogorov Normality test and presented as mean difference and standard deviation (SD) values as shown in Table 1 and Figure 5. The significance level was set at $P \leq 0.05$.

RESULTS

The results comprised the assessment of the mean values and standard deviation (S.D.) measured in millimeters (mm) of the bucco-lingual and mesio-distal bone height around the six implants in the posterior mandibular regions at 0, 3, and 6 months after prosthesis delivery

using two different types of splints; the 3D Printed Digital versus the Acrylic Resin Conventional Occlusal Stabilization Splints as presented in Table 1 and Figure 5. All implants were regarded as osseointegrated at the conclusion of this study. None of the participants showed signs of clinical implant mobility in any direction or peri-implantitis or mucositis. On palpation, percussion, or function, no discomfort was detected.

Comparison between conventional and 3D printed groups:

The Independent t-test was utilized to compare the two groups and presented in Table 2 and Figure 6. Statistical Analysis revealed a non-significant difference between both groups regarding Mesio-distal, Bucco-lingual, and overall bone height values at all intervals as $P>0.05$.

Comparison between buccolingual and mesiodistal surfaces

A Comparison between the Bucco-lingual and Mesio-distal bone height values of both groups at different intervals was performed by using Paired t-test and presented in Table 3 and Figure 7. In the conventional acrylic resin group, there was a significant difference between them only at baseline as $P<0.05$ (Bucco-lingual was significantly higher than Mesio-distal), while there was an insignificant difference between them as $P>0.05$ after 3 months and after 6 months in the conventional group. In the 3D Printed Nightguard group, Statistical Analysis revealed an insignificant difference between all the time intervals as $P>0.05$.

Comparison between different time intervals

A Comparison between different time intervals was performed by using the One Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons and presented in Table 3 and Figure 7. Statistical analysis revealed that in the conventional acrylic resin group, the baseline was significantly the highest (letter a) while there was an insignificant difference between after 3 and after 6 months (Same letter b) in both buccolingual and mesiodistal surfaces. In the 3D printed group, there was a significant difference between all intervals (baseline was significantly the highest while after 6 months was significantly the lowest).

DISCUSSION

Analysis of the peri-implant bone height in this study showed that there was a change in the bone height surrounding the implants in both groups within all surfaces and during the whole study period. This may be explained by the fact that, as per Parfitt [17], the interface between implants and bone begins to remodel as a result of two main causes: surgical trauma and the mechanical loading response induced by the delivery of the implant prosthesis, which causes the inevitable crestal bone resorption. Additionally, the values of bone height changes found in this study were consistent with what has been reported in other studies performed by Tosun et al. [13] and De Rouck et al.[18]

Implant-protected occlusion (IPO) has been applied for implant prostheses in this study as recommended by Misch and Bidez [19] reduction of crown height (vertical offset), reduction of cuspal inclination, and narrowing of the mesio-distal and bucco-lingual dimensions of the occlusal table which included: reduction of crown height (vertical offset), reduction of cuspal inclination and narrowing the mesio-distal and bucco-lingual dimensions of the occlusal table. Weinberg [20] also recommended a 1.5mm flat fossa (area) for wide freedom in centric occlusion which was also performed in this study.

Figure 1: Paralleling rods placed in the three osteotomies showing parallelism from a buccal view

Figure 2: a: Metal framework tried in the patient's mouth and checked for fit b: Provisional restorations delivered to the patients

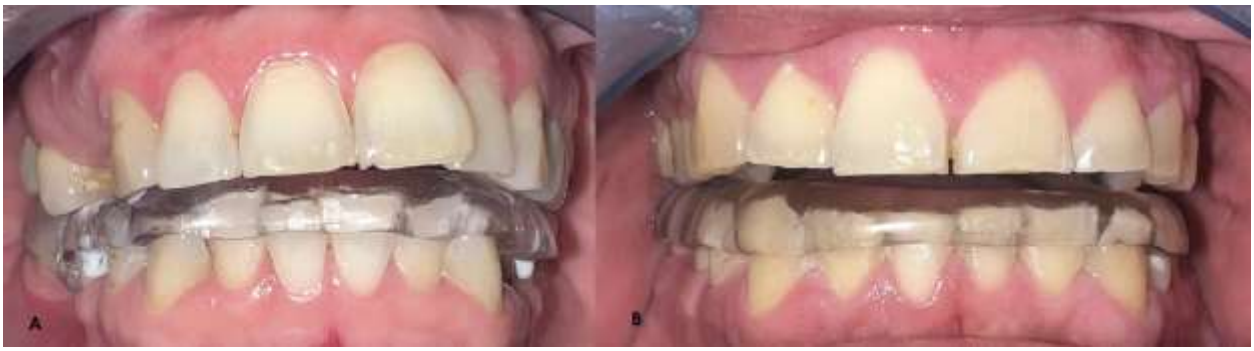

Figure 3 a: Digital 3D Printed Nightguard delivered to the patients 48 hours after surgery b: Conventional Acrylic Resin Nightguard delivered to the patients 48 hours after surgery

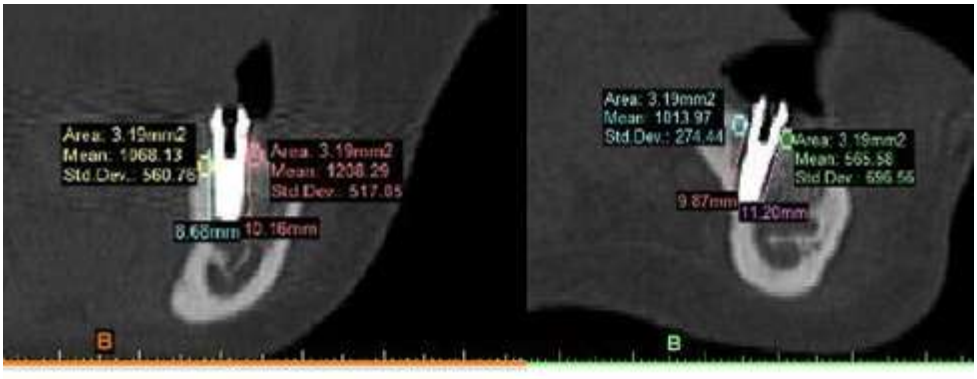

Figure 4: Sagittal and Coronal cuts where Bone height measurements were performed

Table (1): minimum, maximum, mean, and standard deviation of all surfaces in conventional and 3D printed groups at different intervals:

	Interval	Surface	Minimum	Maximum	Mean	Standard Deviation
Conventional	Baseline	Buccolingual	10.34	11.41	10.97	0.3
		Mesiodistal	10.3	11.29	10.75	0.32
		Overall	10.50	11.35	10.86	.27
	After 3 months	Buccolingual	10.08	11.02	10.52	0.34
		Mesiodistal	9.99	11.02	10.41	0.3
		Overall	10.19	11.01	10.46	.28
	After 6 months	Buccolingual	9.81	10.74	10.26	0.23
		Mesiodistal	9.88	10.83	10.19	0.25
		Overall	9.99	10.79	10.22	.21
3D printed	Baseline	Buccolingual	10.43	11.5	10.93	0.28
		Mesiodistal	10.67	11.4	11.08	0.19
		Overall	10.76	11.3	11.001	0.15
	After 3 months	Buccolingual	10.21	11.31	10.57	0.31
		Mesiodistal	10.24	11.17	10.68	0.3
		Overall	10.315	11.24	10.63	0.23
	After 6 months	Buccolingual	10.05	11.02	10.3	0.26
		Mesiodistal	10	10.71	10.32	0.25
		Overall	10.105	10.79	10.31	0.18

Min: minimum Max: maximum M: mean SD: standard deviation

Table (2): Comparison between different groups (Independent t-test) at all intervals regarding all surfaces:

Surface	Interval	Conventional		3D printed		Difference (Independent t-test)				
						P value	MD	SEM	95% CI	
		M	SD	M	SD				L	U
Mesiodistal	Baseline	10.75	0.32	11.08	0.19	0.08	0.33	0.16	-0.05	0.71
	After 3 months	10.41	0.30	10.68	0.30	0.19	0.27	0.18	-0.16	0.71
	After 6 months	10.19	0.25	10.32	0.25	0.43	0.13	0.15	-0.23	0.49
Buccolingual	Baseline	10.97	0.30	10.93	0.28	0.65	-0.04	0.11	-0.20	0.16
	After 3 months	10.52	0.34	10.57	0.31	0.81	0.05	0.21	-0.42	0.52
	After 6 months	10.26	0.23	10.30	0.26	0.80	0.04	0.15	-0.31	0.39
Overall	Baseline	10.86	0.27	11.00	0.15	0.34	0.14	0.13	-0.17	0.45
	After 3 months	10.46	0.28	10.63	0.23	0.32	0.17	0.16	-0.21	0.52
	After 6 months	10.22	0.21	10.31	0.18	0.48	0.09	0.12	-0.19	0.37

M: mean SD: standard deviation P: probability level which is significant at $P \leq 0.05$
Counts with the same superscript letters were insignificantly different as $P > 0.05$
Counts with different superscript letters were significantly different as $P < 0.05$

Table (3): Comparison between different surfaces (Paired t-test) and comparison between different intervals (One Way ANOVA test and Tukey`s Post Hoc test) in each group separately

Group	Intervention	Buccolingual		Mesiodistal		Paired Differences					t	df	P value
						M	SD	SEM	95% CI				
		M	SD	M	SD				L	U			
Conventional	**Baseline**	10.97 a	0.30	10.75 a	0.32	0.22	0.31	0.08	0.05	0.39	2.76	14.00	0.02*
	After 3 months	10.52 b	0.34	10.41 b	0.30	0.11	0.29	0.07	-0.05	0.26	1.45	14.00	0.17
	After 6 months	10.26 b	0.23	10.19 b	0.25	0.07	0.21	0.05	-0.05	0.18	1.23	14.00	0.24
	P value	<0.0001*		<0.0001*									
3D printed	**Baseline**	10.93 a	0.28	11.08 a	0.19	-0.15	0.37	0.09	-0.35	0.05	-1.58	14.00	0.14
	After 3 months	10.57 b	0.31	10.68 b	0.30	-0.11	0.42	0.11	-0.34	0.12	-0.99	14.00	0.34
	After 6 months	10.30 c	0.26	10.32 c	0.25	-0.02	0.37	0.09	-0.22	0.18	-0.21	14.00	0.84
	P value	<0.0001*		<0.0001*									

M: mean SD: standard deviation P: probability level which is significant at $P \leq 0.05$
Counts with the same superscript letters were insignificantly different as $P > 0.05$ Counts with different superscript letters were significantly different as $P < 0.05$

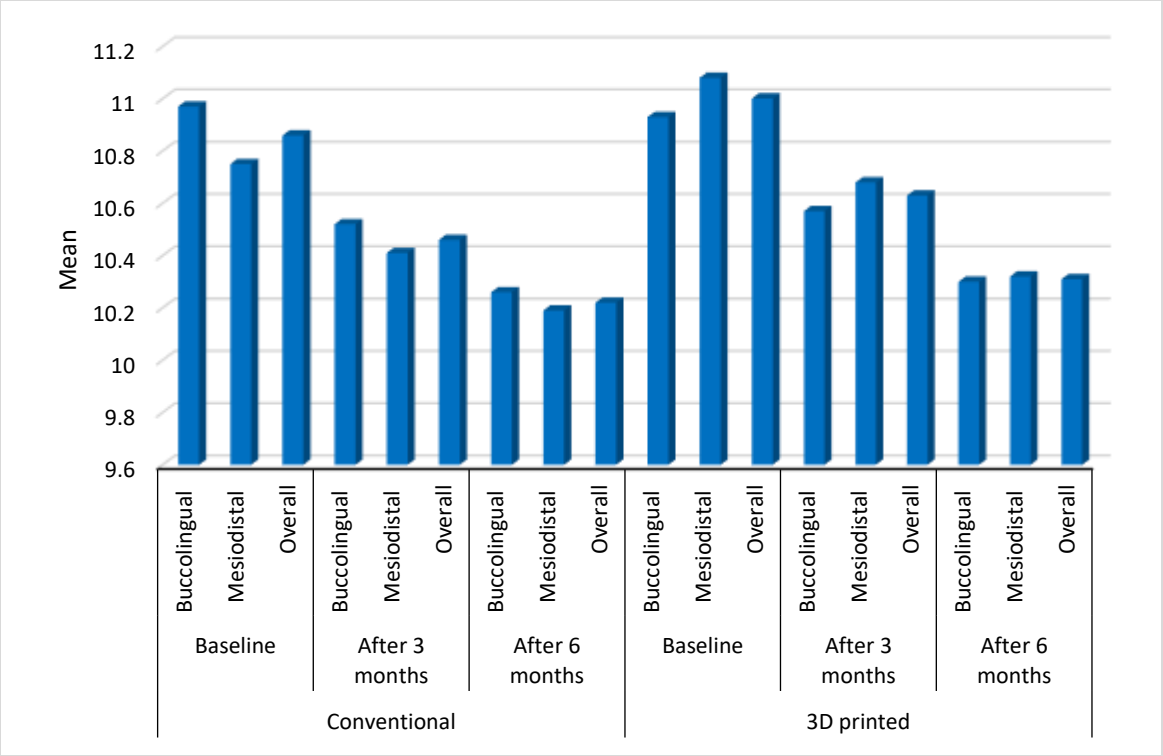

Figure 5: bar chart showing the mean of all surfaces in conventional and 3D printed groups at different intervals.

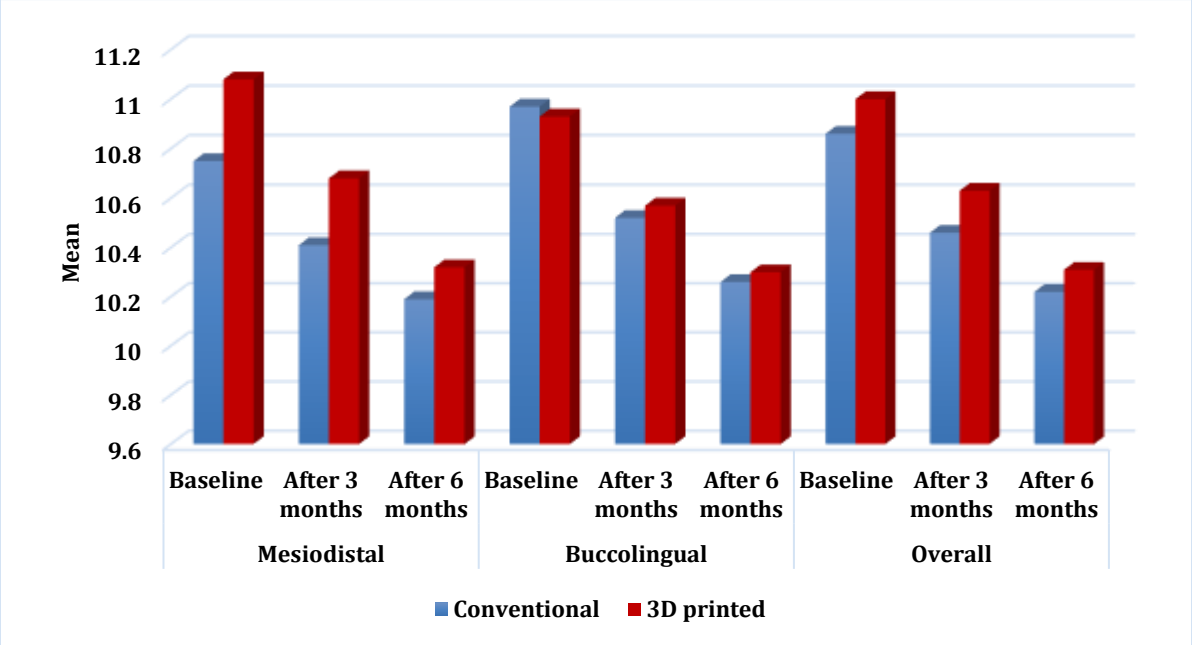

Figure (6): bar chart showing Comparison between different groups at all intervals regarding all surfaces

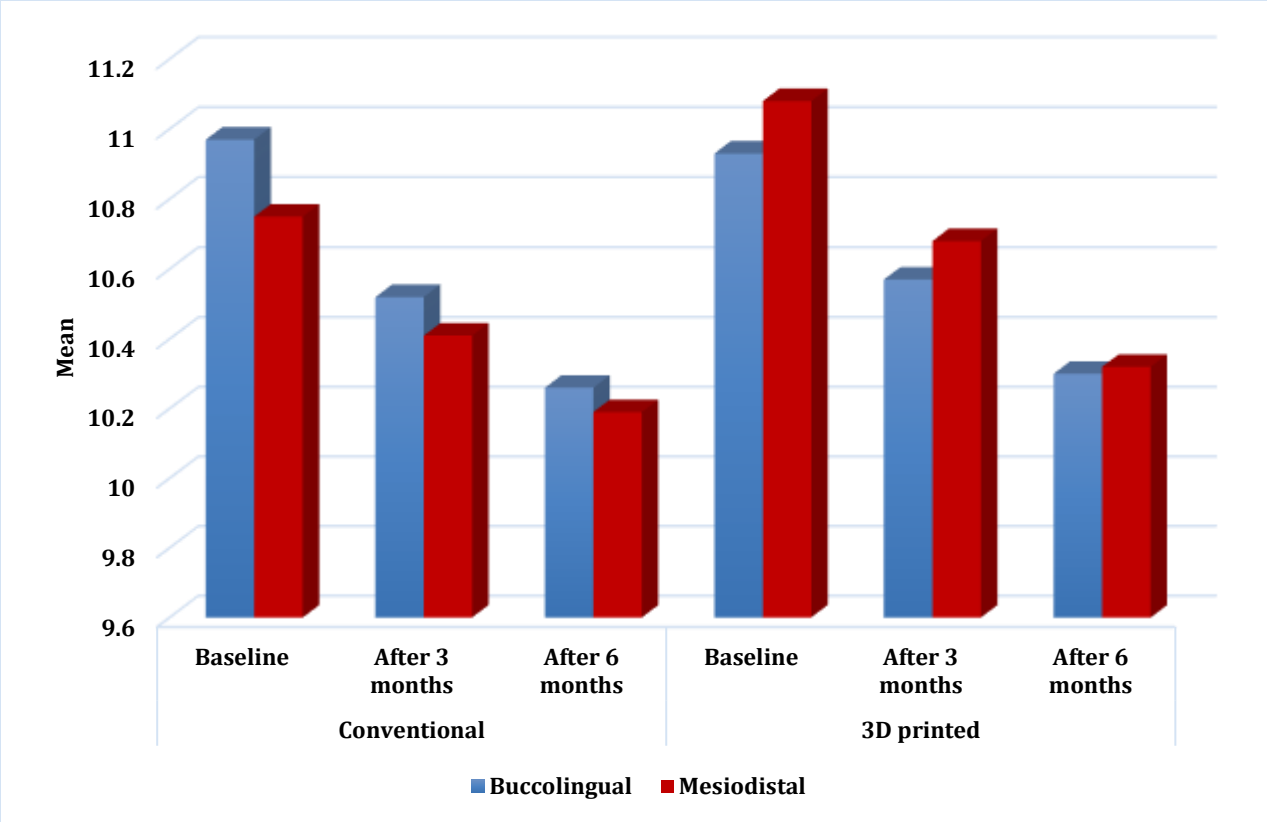

Figure 7: Bar chart showing a comparison between different surfaces at different intervals.

The findings of the current study indicated that there was an insignificant difference between the Bucco-lingual and the Mesio-distal surfaces after the 3 and 6 months intervals in both groups while a significantly higher mean bone height values at baseline or at the time of implant insertion only in the conventional acrylic group which might be attributed to the amount of mandibular bone height to begin with in the conventional acrylic group. This is an indication that the use of Nightguards in patients with parafunctional habits and sleep-related bruxism reduced the mesio-distal and bucco-lingual offset loads to the crestal implant/bone interface. This is to a study performed by Kitamaru et al. [21] who found that under lateral excursive stresses and parafunctional habits, high compressive and tensile stresses occurred near the buccal and lingual sides and decreased rapidly with the depth of resorption while under axial loadings, mainly compressive stresses were found at the implant apices in all models. Goswami [22] also agreed that implant crestal bone loss was more on the buccal side even under delayed loading protocol.

Accordingly, this explains why there was a more favorable equalization of bone reaction in the mesio-distal and bucco-lingual surfaces and confining of the occlusal forces to the healing implant/bone interface within the physiologic limits ("physiologic over-load zone") as described by Frost [23] thus enhancing bone trabecular deposition and crystal growth which probably reduced the strain transmitted to the implant/bone interface and better biomechanical

load distribution during lateral excursive movements of the mandible during sleep.

Another study performed by Tosun et al. [13] also showed that the use of an acrylic resin night guard or occlusal device showed a satisfactory reduction in the unfavorable lateral stresses and overloading improving the innocuous vertical loading transmitted to the supporting bone around dental implants in patients with parafunctional habits (clenching or grinding).

Statistical Analysis of this study also revealed an insignificant difference between both groups regarding bone height values at all intervals which agreed with Berntsen et al. [24] and Salmi et al. [25] who compared occlusion of conventional and 3D printed stabilization splints and found no significant difference between the two splints in terms of occlusion and fit. The utilization of free software programs to fabricate occlusal stabilization appliances has also been reported to show excellent results of accuracy in both the occlusal and fitting surfaces of the device as reported by Szymon et al. [26] and which supports the results of this study. The use of digital technology gives the additional advantage that the design, fabrication, and cutting precision are fast and efficient, reducing errors in the model and plaster transfer process as also reported in this study [8]. Furthermore, the data is stored in the computer, and the dentist can make an identical splint at any time, which reduces the patient's adaptation process and greatly saves medical resources as agreed by Marcel et al. [9]. Additionally, the scanners are believed to improve the workflow in terms of consistent results and reduction of chair side time as reported by Glisic et al. [27]. Although not included in our outcomes and statistically analyzed, the digital workflow for fabricating stabilization splints significantly reduced the chair side time especially laboratory workflow and impression-taking visits as agreed upon by other authors [28].

CONCLUSION

Based on study results, both the 3D Printed Digital Splints and the conventional acrylic stabilization splints showed reliable results on bone height changes around implants and either types should be advised to be worn for protecting the underlying fixed implant prosthesis and supporting structures in patients diagnosed with sleep related bruxism. The 3D printed digital splints can be a better choice due to being easier, cheaper, and faster to deliver than the conventionally constructed Night guard.

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