ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

AIN SHAMS DENTAL JOURNAL
Official Publication of Ain Shams Dental School
June2023 • Vol. 30

Effect of Occlusal Scheme in All on 4 Implant Retained Overdenture on Occlusal Fore Analysis Using T-Scan

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Aim: The aim of this study was to evaluate stress distribution on hybrid implant prosthesis (provisional prosthesis) with Lingualized and monoplane occlusal scheme using T-scan device.
Materials and methods: Fourteen male complete edentulous patients were selected to participate in the current study. The patients were rehabilitated with upper complete dentures and lower hybrid prosthesis (provisional prosthesis) using the all on four concept with two occlusal schemes. The patients were randomly divided into 2 equal groups. Group A: Patients were rehabilitated with hybrid implants prosthesis with lingualized occlusal schem. Group B: Patients were rehabilitated with hybrid implants prosthesis with monoplane occlusal scheme. Completely guided surgery was done, T-scan occlusal force distribution records was taken in centric, protrusive and lateral movement.
Results: The difference in both groups of all intervals was not statistically significant ($p>0.05$).
Conclusion: Both types of occlusal schemes used (monoplane and lingualized) are considered as "non-traumatic protective occlusion" for All on four implant prosthesis.

Keywords: All on four, monoplane occlusion, Lingualized occlusion, T Scan

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Introduction

For the rehabilitation of edentulous patients, dental implants have been routinely employed. providing the patient with a fixed prosthesis was a challenge assumed, especially in cases with highly resorbed ridges, which necessitated difficult modifying treatments before implant placement. Some of these need complicated surgical operations, grafts, time, and more cost for the patient, making it more difficult for them to meet their goals. (1)

The all-on-4 approach was developed to rehabilitate cases with severely resorbed ridges. It permits immediate prosthetic rehabilitation of patients with minimum surgery time using a decreased number of implants and without sacrificing the expectations of treatment success. (2)

Because implant-supported prostheses are not always possible due to the presence of vital anatomical structures such as the mandibular canal or maxillary sinus. Distally tilted implants, which are often much longer than implants typically positioned axially in the distal positions, were proposed at the start of the era, allowing for the utilization of denser bone in the anterior mandible for improved bone anchorage. Furthermore, inclined distal implants could replace posterior teeth without extended cantilevers and the necessity for bone grafting. (3,4)

In the mandible, angling the posterior implants distally may offer a biomechanical advantage in cases where it is difficult to obtain an implant arrangement with appropriate AP spread. (5) The "all-on-four" treatment concept was developed to utilize as much of the remaining bone in atrophic jaws as possible, allowing for immediate function with no need for guided bone regeneration therapies, which raise treatment costs, patient illness, and difficulties. (3)

Occlusal restoration principles that have evolved in complete dentures and fixed tooth-supported restorations must be reevaluated with the continuous development and advance in implant dentistry. (4) Many schools of thought disagree on the best posterior occlusal design for a complete denture. The type of occlusal surfaces and how they were placed, were thought to be critical for superstructure fabrication. The importance of lingualized balanced occlusion and monoplane occlusion was postulated. (5)

The intelligent use of the occlusal form of artificial teeth is serious for the health of the supporting structures. There does not appear to be one occlusal form that is ideal for all types of ridges. Anatomical, semi-anatomical, and non-anatomic tooth shapes were chosen for the creation of a particular scheme. (6)

Several methods have been used to diagnose, evaluate, and balance occlusal forces over the years. None of them exactly detects simultaneous contact and records both the timing and biting force. A computerized system for an occlusal examination called T-scan was established in 1987 to aid in the measurement of occlusal biting forces and the acquisition of consistent and relevant occlusal data for occlusal contact evaluation. (6)

The T-scan system is based on Microsoft software, with ultra-thin disposable sensors that patients are asked to bite down on. The analysis of occlusal contact data is transferred to a computer and converted into a dynamic movie. This film can be viewed as a full-color three-dimensional or two-dimensional graphic. It displays the percentage of force applied to each tooth, quadrant, and half arch. It also allows the dentist to show the patient's bite in real-time, from the beginning to the end. (7)

This study's objective is to use the T-Scan to examine the distribution of masticatory forces in all-on-four implant prostheses with 2 occlusal schemes. (8)

Materials and Methods

Patient and study design:

Fourteen male completely edentulous patients were selected to participate in this study. The patients were rehabilitated Using the All on four concepts with two occlusal schemes, the upper complete dentures, and lower hybrid implant prosthesis. Patients who participated in the trial met the following requirements: complete edentulism for at least 6 months, free from any systemic diseases, adequate bone width and length good oral hygiene, non-smoking, and more than 12 mm interarch space.

Patient grouping:

The patients were randomly divided into 2 equal groups.

Group A: Patients were rehabilitated with hybrid implant prostheses with a lingualized occlusal scheme. Group B: Patients were rehabilitated with hybrid implant prostheses with a monoplane occlusal scheme.

Pre-surgical protocol:

A complete denture was constructed using the conventional method. Primary and secondary impressions, facebow, centric and protrusive records were taken for the patients to adjust semi-adjustable articulators and set up the teeth

The lingual cusps of the mandibular posterior teeth of Group A (Lingualized) were positioned medially to a line drawn from the canine's tip to the retromolar pad's middle. The occlusal surface's interlocking transverse ridges were ground. The buccal cusps of the mandibular posterior teeth were reduced to avoid buccal cusp contact in centric and eccentric positions, and the mandibular posterior teeth were positioned with their palatal cusps occluding in the modified central fossae of the maxillary posterior teeth. Fig (1)

Following the monoplane concept of occlusion, flat cuspless teeth in Group B (Monoplane) were placed in a flat occlusal plane. The mandibular ridge starts to bend upward towards the posterior limit of the lower posterior teeth, removing contact between the upper and lower second molars. Fig (2)

Fig. (1): Modification of the tooth following lingualized occlusal concept

Fig. (2): The modification of the teeth following the monoplane concept

Surgical guide construction:

The radiographic markers were fixed on the lower denture flange corresponding to each tooth from the center to the first molars to be used during the dual scan technique. Planning of 4 conventional implants was done in the interforamenal region for each patient. Two axial implants were placed in the canine region or more anterior favorable to A-P spread and according to the bone, and two posterior implants were planned at the region of the first or second premolars at 30º angulation according to the available bone parameters, three anchor pins were planned to be widely separated. A completely limiting stereolithographic surgical guide was fabricated using liquid photo-polymerized resin cured.

On the day of the surgical procedure, a pilot drill was used for the insertion of the anchor pins, then fixation of the guide was done through the insertion of the anchor pins. Each implant used was 3.75 mm in diameter, and 11.5 mm in length. Neo Biotech CMI IS II active fixture implants were placed in a fully guided surgery using a completely guided surgical guide kit. starting with a tissue

punch which was used to cut through the mucosa at the implant drilling sites through the surgical guide then sequential drilling was done using the drills of the surgical guide kit. Fig (3) The two anterior implants were oriented axially while the two posterior implants were tilted with a 30-degrees angulation guided by the secured surgical guide. Each implant was inserted by the contra through the guide. Fig (4)

Each implant was inserted in a submerged position 30-degree multiunit angled abutments were placed at the posterior implants and 0-degree straight multiunit abutments were placed at the anterior implants, so they all emerged toward the occlusal surface of the denture the screw of the multiunit abutment was torqued at 25Ncm. Fig (5)

Fig. (3): Sequential drilling using drills of surgical guide kite

Fig. (4): Insertion of the implant through the guide.

Fig. (5): Multiunit abutments for the screw-retained prosthe

Within one week from surgery. The titanium sleeves were screwed into place on the multi-unit abutments. Acrylic resin material was injected around the spaces created in the denture around the blocked-out temporary copings. Fig (6)

The sensor support was tried in the patient's mouth to show the correct size, sensor's support was attached to the t-scan handle with the sensor position guide faced up until it clicks into place. The sensor was inserted into the mouth so that the guide touches the central incisors at the midline. Fig (7) The patients were asked to clench and tooth contact was observed on the screen the record is taken in centric, protrusive and lateral positions. the ideal contact is 3 points of contact, then adjustment was made. fig (8)

Fig. (6): The titanium sleeves (temporary copings) attached to the prosthesis (Hybrid prosthesis)

Fig. (7): The sensor was inserted into the mouth and touched the central incisor at the midline

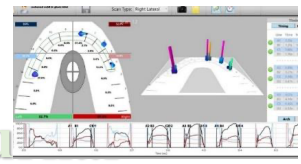

Fig. (8): The ideal contact is 3 points of contact in each denture.

Results

Statistical evaluation:

The Shapiro-Wilk test was used to describe the study's data as mean, standard deviation, and P values for both groups. Data had a non-parametric distribution, so for intergroup comparisons, Friedman's test was used, followed by a Nemenyi post hoc test. For all tests, the significance level was set at p 0.05. R statistical analysis software for Windows,

version 4.1.2, was used to conduct the statistical analysis.

Table (1) shows that group (A) recorded higher biting forces on the right side (46.35±7.85, 31.70±1.98, 42.15±3.04) at the baseline,3 and 6 months respectively While group (B)showed values (16.85±2.62, 14.35±9.55, 12.95±14.50) at the baseline,3 and 6 months. The difference in both sides and at all intervals was not statistically significant (p>0.05)

Table (1): Mean and Standard deviation (SD) values for biting force for centric occlusion for different groups *; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Quadrant	Time	Biting force for centric occlusion (Mean±SD)		p-value
		Group (A) Lingualized	Group(B) Monoplane	
Right posterior	Baseline	46.35±7.85	16.85±2.62	0.092ns
	3 months	31.70±1.98	14.35±9.55	0.225ns
	6 months	42.15±3.04	12.95±14.50	0.203ns
Left posterior	Baseline	34.80±10.04	21.30±4.53	0.277ns
	3 months	43.65±12.23	5.50±3.96	0.116ns
	6 months	39.30±14.57	8.25±1.77	0.200ns

Table (2) shows that Group (A) had higher biting force on the right side (10.85±15.34, 16.90±8.63, 8.80±5.37) N at the baseline,3 and 6 months respectively. While Group (B) had values (0.50±0.71, 0.00±0.00, 0.00±0.00) N at the baseline,3 and 6 months. on the left side Group (B) had higher biting forces (29.95±13.65, 27.50±10.61) N at the baseline, 3 and lower value (20.40±6.22) N than Group (B) at 6 months. While Group (A) had values (21.20±29.98, 4.05±5.44, 28.55±13.51 N) at baseline, 3 and 6 months. The difference in both sides at all intervals was statistically insignificant (p>0.05).

Table (3) showed that Group (B) on the right side at baseline and after 3 months had a higher value after 6 months Group (A) had a higher value. In which group (A)values were (23.75±13.36, 32.10±24.32, 48.25±5.87 N) and Group (B) values were (31.70±2.55, 33.80±9.05, 27.05±0.49) N. While in the left side, Group (A) had a higher value at baseline and after 3 months and Group (B) had a higher value after 6 months. In which values of Group (A) were (14.15±20.01, 16.35±23.12, 9.55±13.51 N) and the values of group (B) is (5.75±1.91, 9.75±13.79, 11.95±10.68) N, the difference in both sides at all intervals was statistically insignificant (p>0.05).

Table (2): Mean and Standard deviation (SD) values for biting force for centric occlusion for different intervals *; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Quadrant	Time	Biting force for left lateral movement (Mean±SD)		p-value
		Group(A) Lingualized	Group(B) Monoplane	
Right posterior	Baseline	10.85±15.34	0.50±0.71	0.515ns
	3 months	16.90±8.63	0.00±0.00	0.221ns
	6 months	8.80±5.37	0.00±0.00	0.260ns
Left posterior	Baseline	21.20±29.98	29.95±13.65	0.756ns
	3 months	4.05±5.44	27.50±10.61	0.148ns
	6 months	28.55±13.51	20.40±6.22	0.547ns

Table (3): Mean and Standard deviation (SD) values for biting force for protrusive movement for different groups *; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Quadrant	Time	Biting force for right lateral movement (Mean±SD)		p-value
		Group (A) Lingualized	Group (B) Monoplane	
Right posterior	Baseline	23.75±13.36 N	31.70±2.55 N	0.553ns
	3 months	32.10±24.32 N	33.80±9.05 N	0.939ns
	6 months	48.25±5.87 N	27.05±0.49 N	0.121ns
Left posterior	Baseline	14.15±20.01 N	5.75±1.91 N	0.659ns
	3 months	16.35±23.12 N	9.75±13.79 N	0.768ns
	6 months	9.55±13.51 N	11.95±10.68 N	0.863ns

Table (4) showed that on the right side at baseline and after 3 months Group (A) had a higher value after 6 months Group (B) had a higher value. In which values of Group (A) were (18.70±3.68, 25.35±6.43, 12.30±17.39 N) and the values of Group (B) have is (14.00±0.42, 14.65±0.49, 28.95±27.65) N

While in the left side, Group (B) had a higher value at baseline, and Group (A) had a higher value after 3 and 6 months. In which values of Group (A) were (0.75±1.06, 17.45±9.40, 7.15±10.11 N) and the values of Group (B) have is (3.15±1.63, 3.05±1.77, 3.60±3.39) N the difference in both sides at all intervals was statistically insignificant (p>0.05).

Discussion

The management of atrophic mandibular ridge has always been a challenge for clinicians because of the insufficient

retention and support that the ridge offers to complete dentures. When the patient is incapable of tolerating the prosthesis despite all efforts from the clinicians, it can solve the problems. (9)

Table (4): Mean and Standard deviation (SD) values for biting force for protrusive movement for different intervals *; significant ($p \leq 0.05$) ns; non-significant ($p>0.05$)

Quadrant	Group	Biting force for protrusive movement (Mean±SD)			p-value
		Baseline	3 months	6 months	
Right posterior	Lingualized	18.70±3.68^{A}	25.35±6.43^{A}	12.30±17.39^{A}	**0.583ns**
	Monoplane	14.00±0.42^{A}	14.65±0.49^{A}	28.95±27.65^{A}	**0.641ns**
Left posterior	Lingualized	0.75±1.06^{A}	17.45±9.40^{A}	7.15±10.11^{A}	**0.311ns**
	Monoplane	3.15±1.63^{A}	3.05±1.77^{A}	3.60±3.39^{A}	**0.971ns**

Patients were carefully selected and examined to limit human variables and eliminate any traits or habits that could have a negative impact on the study's outcomes. This was accomplished by a thorough medical history, clinical examination, and any necessary laboratory tests. (10)

The patients were chosen because they were devoid of any systemic illnesses that could alter metabolic and catabolic activities and prevent them from hurting the healing process, the state of the bone and soft tissues, or the outcome of this study. (11)

Patients with acceptable alveolar bone quality and quantity were selected, the bone quality around the implants influences its resistance to mechanical loading, while the bone quantity confirms implant and prosthetic success by ensuring wide distribution. (12)

Patients chosen for this study had adequate inter-arch space, which is an important consideration in the fabrication of a mandibular screw-retained prosthesis to ensure adequate space for the prosthesis and dental implant components to avoid over-contoured prosthesis, excessive occlusal vertical dimension, and prosthesis fracture. (13)

Patients were chosen with good oral hygiene and were motivated to follow oral hygiene guidelines, which is a key factor in osseointegration and avoiding plaque formation, which leads to peri-implantitis and, ultimately, implant failure. (14)

All patients' complete dentures were constructed using traditional procedures for all patients and then altered to confirm a precise fit over the supporting tissues, ensuring optimal retention, stability, and patient comfort. (15)

The use of customized guides, enhance accuracy during surgery, and safely avoid critical anatomical landmarks. A study reported the use of guided surgery to obtain optimal insertion with adequate angle inclination, this being an affordable choice for full-arch fixed restorations. (20)

The flapless surgical has several advantages including minimal post-operative discomfort, reduced edema, and immediate prosthetic loading with provisional dentures. (20)

The placement of the two posterior implants in front of the mental foramina tilted in a distal direction avoids the injury of the inferior alveolar nerve and decreases the cantilevers. It allows the increase of the polygonal area for a full fixed prosthesis and provides satisfactory molar support. The differences in angulations of dental implants might not affect implant survival or marginal bone loss (19,21)

Two occlusal schemes were used in this study: lingualized occlusion and monoplane occlusion. Many researchers observed lingualized occlusion as the ideal concept for both complete dentures and overdentures supported by teeth. It lowers horizontal strains, permits mechanical freedom in centric, and controls the leverage brought on by eccentric tooth contact. The second occlusal technique chosen was monoplane occlusion. It can compensate for slight variations in a centric relationship and centric occlusion brought on by processing errors in the acrylic resin denture base and denture settling with use. formalized (16) Setting up modified anatomical teeth with no

buccal contact in lateral and protrusive excursions was done in the lingualized occlusion concept. occlusal forces are applied more lingually to the mandibular denture's center to reduce lateral movement of the lower denture. (17) The monoplane occlusion concept involved placing the cusplcss teeth posteriorly, parallel to the plane of the denture foundation, without any medial or lateral inclination. No vertical overlap between the upper and lower frontal teeth was used to provide zero-degree incisal guidance. (18,19,20, 21)

Many variables contributed to the screw-retained prosthesis. To reduce stresses on the implants, it was decided to minimize cantilevers from the mandibular prosthesis, which would result in eliminating cantilevers on both sides. (22)

The T-scan technology was used to measure occlusal load distribution with the benefit of allowing for occlusion modification. As a result, a more functionally balanced occlusion, increased muscle activity, and periodontal support are provided. Other than the articulating paper, the previous occlusal analysis method was done with a low degree of precision. (23)

In this research, we examine the occlusal force using T scan equipment with two occlusal schemes. On a screw-retained prosthesis, there is a lingualized occlusal scheme and a monoplane occlusal scheme.

The follow-up time immediately, after 3 months, and after 6 months of loading in centric occlusion, protrusive and lateral occlusion shows a statistically non-significant difference between the two groups in the posterior and anterior regions of the arch throughout all follow-up periods.

Under the condition of present study analysis of occlusal force at posterior teeth region with Lingualized and monoplane occlusal scheme revealed, the results were not statistically significant

These results are corresponding to the other study shown, Arksornnukit et al., 24 used denture teeth with various cusp angulations (00, 200, and 330) to assess force transmission and distribution. Their findings showed that, in comparison to cusped denture teeth, (monoplane 00) teeth provided much lower average pressure and lower maximum pressure transmission. From a biomechanical perspective, horizontal (lateral) and vertical force vectors are created when vertical forces strike an inclined occlusal plane. Additionally, the possibility of cuspal interlock increases with cusp angulation, further highlighting these lateral stresses, these writers think that because the direction of forces is essentially vertical, monoplane teeth have the benefit of restricting, if not completely eliminating, the creation and transmission of destructive non-axial forces. (25,26)

The forces transmitted to the underlying structure depend on the type and shape of the occlusal surface. (27,28)

While another study that is concluded Lingualized occlusal scheme showed less stresses transmitted to dental implants and their supporting structures as reflected in decreased per implant bone loss. (2)

Türker et al. (29), Using a finite element analysis method, the stress distributions caused by the occlusal load generated while chewing by prostheses attached to implants that follow the All-on-Four concept are assessed on implants and alveolar bone. Canine-guided occlusion, group function occlusion, bilateral balanced occlusion (BBO), lingualized occlusion, and monoplane occlusion are a few different occlusal methods. were evaluated. In this load distribution, the posterior area of the functioning side had the highest stress values. High stress in the posterior area may have been caused by the interaction of rotational loads on the denture at the moment the force was applied. The greatest values were seen in

BBO for protrusive occlusion, regarding the creation of high-stress levels, BBO was followed by lingualized occlusion and monoplane occlusion.
In each of the three conditions, canine-guided occlusion and monoplane occlusion yielded the lowest stress readings.

Conclusion

"Non-traumatic protective occlusion" refers to utilizing both monoplane and lingualized occlusal systems. For All on 4 implant prosthesis.

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