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INFLUENCE OF OCCLUSAL PLANE ORIENTATION ON SOUND PRODUCTION AND MASTICATORY PERFORMANCE IN IMPLANT SUPPORTED MANDIBULAR OVERDENTURE

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ABSTRACT

Statement of problem: Orientation of occlusal plane for edentulous complete denture patients, considered to be one of the most important bases for excellent prognosis, Occlusion of implants supported complete mandibular overdenture also plays an important role in the success and longevity of complete mandibular overdenture.

Objective: The aim of this study was to evaluate the effect of different occlusal plane orientation on masticatory performance and phonetics in implant supported mandibular overdenture.

Materials and methods: Fourteen completely edentulous patients were selected to participate in this study, Four months after implant placement in the canine region, patients were randomly divided into two groups according to the type of occlusal plane orientation. Group I patients received overdentures constructed with posterior occlusal plane adjusted parallel to camper's line while in group II the occlusal plane was adjusted to coincide with 2/3 the height of retromolar pad posteriorly and corners of mouth anteriorly. Masticatory efficiency and speech analysis were evaluated after one week and then one month following overdenture insertion, the results were collected, tabulated and statistically analysed.

Results: ANOVA test revealed statistically non-significant difference between the two groups during chewing the soft food. While there was significant difference between the two groups during chewing the hard food. Voice onset time, After one week and after one month, there was no significant difference between both groups for (v) and (f) sounds, while there was a statistically difference as regard values of voice onset time in different follow up intervals in each group.

Conclusion: No difference achieved in speech and masticatory performance with different orientation of occlusal plane of implant retained mandibular overdentures.

KEYWORDS: masticatory efficiency, dental implants, overdenture, occlusal plane orientation.

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INTRODUCTION

The loss of natural teeth not only results in aesthetic issues to individuals, but can also seriously risk masticatory function. Long-term edentulism could eventually result in bone resorption, temporomandibular disorders or muscle hypotonicity which ultimately leads to direct damage to the masticatory process [1]

Occlusal plane orientation is one of the most important clinical procedures in removable prosthodontic treatment for edentulous patients as it is a vital and important basis for tooth arrangement.

The occlusal plane position is considered to be the primary link between function and aesthetics.

Occlusal plane is defined according to Glossary of Prosthodontics terms as the average plane established by the incisal and occlusal surface of the teeth [2].

Determination of the inclination of occlusal plane (IOP) is an important step in the construction of equilibrated complete dentures, because bilaterally balanced occlusion is the situation of choice [3]. Camper plane and the inter-pupillary line are the usual morphologic guides used with the Fox plane and Leary parallelometer[4].

The position of occlusal plane in denture wearers should be as close as possible to the plane, which was previously occupied by the natural teeth [5], e.g., retromolar pad, lateral border of the tongue, the buccinator groove and commissures of the lip [6].

Control of implant occlusion is so important to ensure minimal and even stress distribution to the osseointegrated abutment fixtures, which cannot move to compensate for possible occlusal and other technical discrepancies so optimal implant load and success can be achieved.

Thus, if a clinical condition is likely to increase biomechanical stresses, dentists should implement occlusal mechanisms to decrease the stresses and develop an occlusal plane that minimize risk factors and allows the restorations to function in harmony with the rest of the stomatognathic system [7-8].

Such position of the occlusal plane provides normal function of the tongue and cheek muscles thus enhancing the denture stability [9] .

The question which arises in clinical practice is how to discover which position was occupied by the natural occlusal plane after the loss of natural teeth.

The occlusal plane in anterior and posterior regions may vary and therefore these should be evaluated separately [10].

The anterior maxillary occlusal plane may be determined by lips relationship at rest and when smiling, however, speech provides for accurate teeth position,

As regards the posterior region various landmarks have been used to orient the occlusal plane in the mandible.

The aim of this study was to evaluate the effect of two different occlusal plane orientation (Ala tragus line and Retromolar pad) on masticatory performance and sound production in implant supported mandibular overdenture.

MATERIALS AND METHODS

Patients' Selection

Fourteen patients were selected from the out-patient clinic of removable prosthodontics department faculty of dentistry, Cairo University according to the following criteria:

Inclusion criteria

- Having completely edentulous arches.
- Age ranging between 50-60 years.
- Free from any systemic diseases that would affect bone metabolism such as hormonal disorders as diabetes, thyroid or parathyroid disorders.

- Patients were free from any signs of oral pathology.
- Patients were free from habits as clenching, bruxism, they also had no temporo-mandibular joint disorders.
- The selected patients exhibited Angle class I maxilla-mandibular relationship.
- The residual alveolar ridge exhibited adequate height and width and was covered with firm fibrous mucoperiosteum.

Exclusion criteria

- Patients giving history of recent administration of chemotherapy or radiotherapy were not selected.
- Patients were selected with an inter-arch space not less than 10 mm to accommodate the height of the implant used, denture base and teeth.
- Patients having blood diseases, lowered immunity or who were chronic drug users affecting the condition of oral tissues were excluded.
- Patients had completely edentulous lower arches from at least six months. Each patient was clinically and radiographically examined.
- All patients were having an old complete denture.

Patients' approval:

Information concerning the line of treatment, procedure and materials were described to the patients. Patients accepting the treatment signed a written consent form given by the dental ethics committee. All reasonable steps to protect the security of the personal information and privacy of the patient's protected health information were taken. Patients were given notice about their privacy practices, their legal duties, and their rights. All patients' data were kept confidential.

Patients were informed about the benefits of the research including obtaining a well-fitting and retentive denture. In case of failure of implants, patients were informed that a regular mandibular complete denture will be constructed.

In each subject, two mandibular fixtures (Multisystem implant, Italy) were placed at the canine region following the surgical procedure **(fig. 1).**

Fig. (1): Implant positions and directions verified with the paralleling tools

After 4 months healing period through which the patient was wearing the old denture lined with tissue conditioning material, the covering screws were placed. four weeks later, impressions were made and the healing abutments were placed. the patients were divided randomly into two groups according to the type of occlusal plane oriented.

Group I patients received overdenture constructed with posterior occlusal plane adjusted to be parallel to ala tragus line (camper's line) using tongue depressor **(fig. 2)**, while Group II the occlusal plane was adjusted to coincide with two-third the height of retromolar pad posteriorly and coincide with the corners of the mouth when lip is relaxed anteriorly. centric occlusion was developed at centric relation on semi-adjustable articulators. Artificial teeth were balanced for centric and eccentric jaw relations.

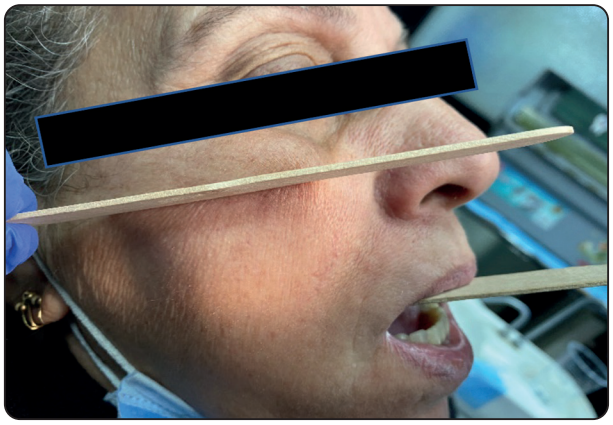

Fig. (2): posterior occlusal plane adjusted to be parallel to ala tragus line (camper's line) using tongue depressor

Dentures for both groups were finished, inserted and adjusted as the conventional methods.

Evaluation of masticatory efficiency.

One month following the denture insertion, masticatory efficiency tests were carried out, patients was chewing standardized pieces of different food texture. They were one cm^3 of banana and one cm^3 of carrot, these represent soft and hard food.

Four measurements were recorded during chewing food specimens.

1- Number of chewing strokes up the first swallow.
2- Number of chewing strokes till the patient's mouth become clear of food.
3- Time (in seconds) up to the first swallow.
4- Time (in seconds) till the patient's mouth become free of food.

Two investigations were recording the measurements throughout the study independently.

The patient chewed one piece of each food for five times, the mean of the five recording was considered the masticatory efficiency parameter for that patient.

Spectral analysis

Speech samples were recorded using computerized speech lab (CSL) spectrogram (CSL Kay Elemetric Model 4300, USA) in phonetic unit **(fig.3),** ENT Department, kasr El Einy hospital.

Fig. (3): Computerized speech lab device

All patients were subjected to analysis of their signal after it was captured sampling rate of 11025 H2 and sentence length of 2 seconds in comfortable amplitude and pitch.

Computers equipped with the proper hardware can convert the analogue voltage variations into digital sound waveforms by a process called analogue-to-digital conversion.

The sound was represented by spectrogram and analysed in the form of the voice onset time (measured by the distance along the horizontal axis) expressed in milliseconds (m/sec).

Each patient was asked to read sentences three times, each denture was evaluated two times one week and after one month.

The results of this study were collected tabulated and statistically analysed in (table 1-4).

RESULTS

The results of this study were shown in table (1-4), the mean value of strokes number up to swallowing, ANOVA test revealed no statistically significant difference between the two groups during chewing the soft food.

While there was a statistically significant

difference between the two groups during chewing the hard food (table I).

As regarding time of swallowing in seconds, ANOVA test revealed that the difference between both groups was no statistically significant during chewing soft food, while there was significant during chewing hard food. (table II).

Voice onset time: (table 3,4)

After one week, there was no significant difference between both groups for (v) and (f) sounds.

There was no significant difference between both groups after one month for (v) and (f) sounds, While significant difference as regard values of voice onset time in different follow up intervals in each group.

Regarding number of strokes until first swallow the greatest mean value was recorded in group II whereas the lowest mean was recorded in group I.

On the other hand, for the mouth clearance, the greatest mean value was recorded ingroup11 whereas the lowest mean was recorded in group I

TABLE (I): Comparison of the effect of different occlusal plane in masticatory efficiency during chewing soft and hard food.

		Group I		**Group II**		**P ≤ 0.05**
		Mean	SD	Mean	SD	
Soft food	First swallow	7.9	2.4	8.5	2.5	0.082 NS
	Mouth clearance	9.5	2.4	10.7	2.9	0.062 NS
Hard food	First swallow	17.1	2.01	18.9	2.5	0.048*
	Mouth clearance	23.5	1.2	24.7	1.8	0.049*

Significant

TABLE (II): Comparison of the effect of the different occlusal plane on masticatory efficiency regarding time of swallowing in seconds during chewing soft and hard food.

		Group I		**Group II**		**P**
		Mean	SD	Mean	SD	
Soft food	Time in seconds until First swallow	8.44	1.87	9.22	1.75	0.295 NS
	Time in seconds until Mouth clearance	10.56	1.84	11.33	1.05	0.348 NS
Hard food	Time in second until first swallow	20.6	0.31	21.8	0.36	0.047*
	Time in seconds until Mouth clearance	26.2	0.56	27.3	1.08	0.049*

Significant

NS: Non significant

TABLE (III): Mean, standard deviation (SD) values of voice onset time (m/s) in different follow-up intervals.

Sound	Groups	Follow-up (mean+/- SD)		P-value
		After 1 week	After 1 month	
V sounds	Group I	0.044+/-0.004	0.041+/-0.004	<0.001*
	Group II	0.043+/-0.004	0.040+/-0.004	<0.001*
F sounds	Groups I	0.048+/-0.004	0.046+/-0.004	<0.001*
	Group II	0.050+/-0.004	0.046+/-0.004	<0.001*

significant (P ≤ 0.05)

TABLE (IV): Mean, standard deviation (SD) values of voice onset time (m/s) in different groups.

Sound	Follow up	groups (mean+/- SD)		P-value
		Group I	Group II	
V sounds	After 1 week	0.044+/-0.004	0.043+/-0.004	0.857 NS
	After 1 month	0.041+/-0.004	0.040+/-0.004	0.826 NS
F sounds	After 1 week	0.048+/-0.004	0.050+/-0.004	0.836 NS
	After 1 month	0.046+/-0.004	0.046+/-0.004	1 NS

NS: non-significant (P ≤ 0.05)

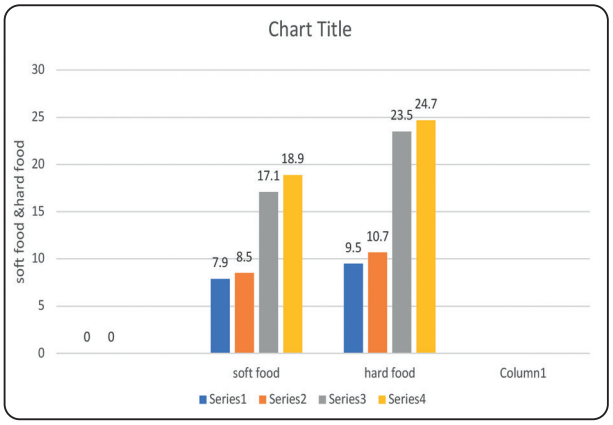

Fig. (1) Bar chart show the difference between the two groups related to soft and hard foods during the first swallow and mouth clearance

DISCUSSION

In this study, two fixtures are implanted in the anterior part of the mandible between the two mental foramina, where the optimal bone quality and quantity for implant support [11].

Four months healing period was left before any implant is loaded to permit bone response and osseointegration [12].

All patients were satisfied with their prothesis both functionally and aesthetically till the end of the follow up period. In group I all patients received their dentures where the maxillary rim was adjusted so that the occlusal plane is parallel to the interpapillary line anteriorly [13], in this research the occlusal plane was adjusted to be parallel to the ear-nose plane drawn from the inferior border of the ala of the nose to the middle point of the tragus of the ear which is in agreement with other researches [14].

In group II all patients received the dentures with the mandibular wax rim adjusted anteriorly at the level of the mouth corner and to coincide with two-third the height of the retromolar pads posteriorly [15,16].

The results of this study showed that harder food required higher chewing rates, the number of cycles

increase with the hard food rather than with the soft food and the time taken by the patients to form a bolus of food to be swallowed increased in case of hard food than soft food in both groups [17].

Spectral analysis showed significant decrease in values of voice onset time in sounds (f) and (v) by time in each group. There were no significant difference between group I and group II in pronunciation of both sounds after one week and one month from denture insertion.

These results were in agreement with a study concluded that adaptation potential in elderly patients is usually diminished and speech function could be compromised [18,19,20].

The results of this study showed non-significant difference between both groups at different intervals of follow up. This was with agreement with other studies[21,22] which found that both methods for occlusal plane determinations are reliable methods.

CONCLUSION

Within the limitation of this study, orientation of occlusal plane by ala-tragus line and retromolar pad methods can be used successfully in implant supported complete mandibular overdentures without affecting phonetics testing and masticatory function.

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