Fourteen male patients were selected from outpatient clinic of the prosthodontic department, Faculty of Dentistry, Suez Canal University to compare between the effects of lingualized and linear occlusal concepts on ridges in mandibular overdenture cases. The mandibular and maxillary arches were completely edentulous. Patients were randomly classified into two equal groups; each group consists of 7 patients: the group I received complete maxillary dentures and implant supported mandibular overdenture constructed by lingualized occlusal concept (GI). The group II received complete maxillary dentures and implant supported mandibular overdenture constructed by linear occlusal concept (GII). All patients received two threaded titanium implants in mandibular canine region by flapless surgery. The patients were radiographically evaluated at (0, 6, 12, and 18 months from denture insertion) for anterior and posterior mandibular and maxillary residual alveolar ridge height changes. The results of this study showed that linear occlusal scheme showed the least mean of bone reduction in residual alveolar ridges height.

**INTRODUCTION**

Occlusal surface of posterior teeth of complete denture that are harmonious with mandibular movement contributes to masticatory efficiency and dentures stability. Komasa & Gonda (1996)\(^1\)

Equal distribution of loading forces over the supporting tissues is one of the most significant factors affecting stability, patient comfort and acceptance to complete dentures, Zarb et al, (1990)\(^2\)

Occlusal scheme is defined as the form and the arrangement of the occlusal contacts in natural and artificial dentition. The choice of an occlusal scheme will determine the pattern of occlusal contacts between opposing teeth during centric relation and functional movement of the mandible. With dentures, the quantity and the intensity of these contacts determine the amount and the direction of the forces that are transmitted through the bases of the denture to the residual ridges. That is why the occlusal scheme is an important factor in the design of complete dentures Tarazi & Ticotsky, (2007)\(^3\)

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**ABSTRACT**

Fourteen male patients were selected from outpatient clinic of the prosthodontic department, Faculty of Dentistry, Suez Canal University to compare between the effects of lingualized and linear occlusal concepts on ridges in mandibular overdenture cases. The mandibular and maxillary arches were completely edentulous. Patients were randomly classified into two equal groups; each group consists of 7 patients: the group I received complete maxillary dentures and implant supported mandibular overdenture constructed by lingualized occlusal concept (GI). The group II received complete maxillary dentures and implant supported mandibular overdenture constructed by linear occlusal concept (GII). All patients received two threaded titanium implants in mandibular canine region by flapless surgery. The patients were radiographically evaluated at (0, 6, 12, and 18 months from denture insertion) for anterior and posterior mandibular and maxillary residual alveolar ridge height changes. The results of this study showed that linear occlusal scheme showed the least mean of bone reduction in residual alveolar ridges height.
The introduction of dental implants has improved the quality of life for edentulous patients. A conventional complete mandibular denture is less favorable than a complete maxillary denture in terms of retention. However, the use of two implants to retain and support the denture significantly improves the prognosis of mandibular edentulism. Recognizing this, some have considered a two-implant–retained overdenture to be the standard of care for mandibular edentulism. For a two-implant–retained mandibular overdenture, placement of implants in the canine position were preferred. Cornell & John, (2006) (4)

There is a significant increase in displacing forces transmitted to the upper denture by the increased retention afforded to the lower denture by the mandibular implants. This force may be considerably in excess of the retention that has been provided to the upper denture, a retention that was perfectly acceptable when it was opposed only by an un-retentive lower denture. There is a significant change in the patient’s chewing pattern. Before implants were used, the patient probably developed a purely vertical chewing pattern in an attempt to accommodate to the extremely un-retentive lower denture. Once the lower denture is retained by the implants, the patient may revert back to a masticatory pattern that includes lateral and protrusive movements that could be “tripped by” the upper denture. Davies, et al.,(2001) (5)

Improved tissue health and reduced annual residual ridge resorption in supporting tissues that oppose a mandibular implant overdenture had been documented. A more stable occlusion provides a better distribution of occlusal forces and protects the maxillary anterior edentulous ridge. Burns,(2000) (6)

Two occlusal schemes are viewed in this review: lingualized and linear occlusion scheme. Each scheme represents a different concept of occlusion. Comparisons between these schemes are also reviewed and analyzed. Linear occlusion scheme occludes cuspless teeth with anatomic teeth that have been modified (bladed teeth) in order to achieve linear occlusal contacts. Linear contacts are the pin-point contacts of the tips of the cusps of the bladed teeth against cuspless teeth that create a plane. The specific design of positioning upper modified teeth on the upper denture and non anatomic teeth on the lower one is called lingualized occlusion. It is characterized by contacts of only the lingual (palatal, to be more accurate) cusps of the upper teeth with the lower teeth. The lingualized occlusal scheme provides better aesthetics and better stability (in the case of resorbed residual ridges), so the aim of the study was to compare between the effect of lingualized and linear occlusal concepts on anterior and posterior mandibular and maxillary residual alveolar ridge height changes in mandibular overdenture cases.

### MATERIALS AND METHODS

Fourteen male patients were selected from out patient clinic of the prosthodontic department. Faculty of dentistry, Suez Canal University. Their ages ranged between 50-65 years. They were unable to adapt to their conventional complete dentures and were complaining of their lower dentures in respect of retention, stability and discomfort.

**Selection of Patients:**

The following criteria were taken into consideration:

- All patients were free from any systemic diseases, as insulin controlled diabetes, renal or liver disease.
- Patients with severe clenching, bruxism, drug or alcohol abuse were excluded.
- The edentulous ridges were covered with healthy, firm mucosa, free from any severe bony undercut and with adequate inter arch distance.
- The cases were selected with Angle class I, with no tempromandibular joint disorders.

**Grouping of Patients:** Patients were divided into two equal groups

- First group received complete maxillary dentures and implant supported mandibular overdentures constructed with lingualized occlusal concept.
- Second group received complete maxillary dentures and implant supported mandibular overdentures constructed with linear occlusal concept.
Denture Construction

Suitable stock perforated trays were selected and primary alginate (Cavex CA 37, Haarlem, Holland) impression was taken. A study cast was obtained after pouring the impression, on which a special maxillary and mandibular trays were constructed. Border molding were done by the help of green stick compound (KERR. ITALY). The final ZnO/Eugenol impression (Cavex outline, Haarlem, Holland) was taken under continuous border molding. The impressions were boxed and poured in stone (ZETA MUFLE-15067, Nevilicure (AL) ITALY) to obtain master casts. Occlusion blocks on the final casts were constructed.

A face-bow (Universal Gesichtsbogen face bow, Quick master, France) Record was made, to mount the maxillary cast on semi-adjustable articulator (Quick master articulator, France.) Centric occluding relation was recorded at the proper vertical dimension of occlusion using check bite technique to mount the mandibular cast on the articulator in centric relation. Another protrusive interocclusal record were re-established and then positioned on the articulator for adjusting the horizontal condylar path. The lateral condylar path was adjusted according to Hanau equation: \( L = H/8 + 12 \) (L: lateral condylar bath and H: horizontal condylar path).

Setting of teeth according to lingualized concept (group I)

Anatomic posterior acrylic teeth. (Acrylic teeth, Dental supply, Cosmo, Germany) were used for maxillary denture and semi-anatomic posterior teeth were used for mandibular denture. The anterior teeth were arranged with sufficient vertical overlap for esthetic and phonetic demands and adequate horizontal overlap was done to avoid interference in lateral and protrusive mandibular movements. In centric the maxillary lingual cusps of posterior teeth should contact the central fossae of mandibular teeth, while mandibular buccal cusps should not contact the upper teeth. It’s helpful to rotate of the maxillary posterior teeth buccally to allow their clearance without girding.

Setting of teeth according to linear concept (group II)

The masticatory surface of mandibular posterior teeth had a straight, long and very narrow occlusal form resembling a line articulated with flat non-anatomic maxillary teeth. The anterior teeth are arranged with no vertical overlap in lateral or protrusive mandibular movements or provided with sufficient horizontal overlap. The lower posterior teeth were centered over the crest of the residual ridge, and the buccal line of contact arranged in a straight line antro-posterioy. The flat lingual part of mandibular teeth is positioned 0.5mm below the plane of contact. The flat occlusal surface of maxillary posterior teeth arranged parallel to cross arch horizontal plane and the line of contact of lower teeth is centered bucco-lingually.

Implant selection

Root form, single piece, ball and socket, threaded sandblasted titanium implant (TUT Screw type Dental Implant), self-tapping threads of 3.4mm in diameter and 13mm in length was used at the canine area. It is supplied in sterile package with their sockets. Starting a flapless surgery at a very low speed with combined saline irrigation, the surgical stent was seated in the patient mouth to help in identifying the area of flap.

Prosthetic procedure

The two areas opposing newly inserted implants were marked on the fitting surface of the mandibular overdenture. An acrylic abrasive stone was used to relief these areas and to create enough space to accommodate the implant socket. Auto-polymerized acrylic resin was then mixed and added in relieved areas after the sockets were seated on their corresponding ball and the overdenture was inserted over them in the patient mouth. The upper denture was seated in the patient mouth and the patient was instructed to close in centric until complete polymerization.

The follow up for radiographic evaluation of anterior and posterior residual alveolar ridges height changes were done: Immediately, 6, 12, 18 months after denture seating.
Radiographic Evaluation

A panoramic radiograph were taken and processed by automatic processing under standardized condition, then imported to the computer using transparent scanner. (Acerscan-Prisa..620pt/ST/UT., Acerperipherals Inc).

The amount of vertical bone height of an anterior part of the mandible was determined by measuring the length of line (H) perpendicular to the two horizontal lines tangent to the upper and lower border of the mandible at the symphysis area (A&B). The amount of vertical bone height of an posterior part of the mandible was determined by measuring the length of (R&L) lines perpendicular to the two horizontal lines tangent to the upper and lower border of the mandible at mid point between the implant and the angle of the mandible in both sides (C-D), (E-F). The two lengths were summed and the mean of bone height at the posterior area of every patient was calculated (Fig.1). Every bone height length was divided on the length of the implant in the same film to overcome the magnification error.

extended to the height of the alveolar crest. The midline was determined by a line connected a point representing the anterior nasal spine and a point representing the lowest midline point on the anterior maxillary ridge (Fig.2). On both sides of the midline, a line perpendicular to the zygomatic process line from a point representing the midline of the triangle (abc) was drown and extended to the tracing of the height of the alveolar crest. The distance from the intaorbital line to the zygomatic process line was designed as X, the distance from the zygomatic process line to the alveolar crest (the posterior region) was designed as Y, and the distance from the zygomatic process line to the alveolar crest (the anterior region) was designed as Z. Monem,(1995) The means of ratios X/Y, X/Z were calculated to the nearest 0.01mm.

Fig. (1) post operative panoramic radiograph

For the measurement of maxillary alveolar bone resorption: It was measured in the form of ratios .A line was drown joining the inferior margins of the image of the zygomatic processes of the maxilla. A second line was drawn joining the most inferior points of the border of the bony orbit. On both sides, a line perpendicular to the interorbital line from the point where it intersected the inferior border of the orbit was drawn, and then

Fig. (2) measurement of maxillary alveolar resorption

RESULTS

Table (1) shows statistically no significant difference in anterior mandibular bone loss between the two groups during all observation periods. (p≤0.05)

Table (2) shows statistically no significant difference in posterior mandibular bone loss between the two groups at all observation periods .(p≥0.05)

Table (3) shows statistically significant difference in anterior maxillary bone loss between the two groups at (0-6 months & from0-18months). While, no statistically significant difference between the two groups at (6-12month& 12-18month). (p≤0.05)
TABLE(1) Mean of difference in anterior mandibular bone loss between the two groups

<table>
<thead>
<tr>
<th>group</th>
<th>intervals</th>
<th>0-6 months</th>
<th>6-12 months</th>
<th>12-18 months</th>
<th>0-18 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>lingualized occlusion group(GI)</td>
<td>Mean</td>
<td>0.14mm</td>
<td>0.62mm</td>
<td>0.28mm</td>
<td>1.04 mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.195</td>
<td>0.228</td>
<td>0.164</td>
<td>0.416</td>
</tr>
<tr>
<td>linear occlusion group(GII)</td>
<td>Mean</td>
<td>0.14mm</td>
<td>0.42mm</td>
<td>0.27mm</td>
<td>0.83mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.219</td>
<td>0.349</td>
<td>0.157</td>
<td>0.377</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.222</td>
<td>1</td>
<td>0.214</td>
<td></td>
</tr>
</tbody>
</table>

SD = Standard deviation  *significant at p ≤ 0.05

TABLE(2) Mean of difference in posterior mandibular bone loss between the two groups

<table>
<thead>
<tr>
<th>group</th>
<th>intervals</th>
<th>0-6 months</th>
<th>6-12 months</th>
<th>12-18 months</th>
<th>0-18 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>lingualized occlusion group(GI)</td>
<td>Mean</td>
<td>0.24mm</td>
<td>0.52mm</td>
<td>0.44mm</td>
<td>1.2 mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.435</td>
<td>0.192</td>
<td>0.089</td>
<td>0.579</td>
</tr>
<tr>
<td>linear occlusion group(GII)</td>
<td>Mean</td>
<td>0.12mm</td>
<td>0.5mm</td>
<td>0.36mm</td>
<td>0.98mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.084</td>
<td>0.316</td>
<td>0.134</td>
<td>0.507</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.288</td>
<td>0.453</td>
<td>0.152</td>
<td>0.270</td>
</tr>
</tbody>
</table>

SD = Standard deviation  *significant at p ≤ 0.05

TABLE (3) Mean of difference in anterior maxillary bone loss between the two groups

<table>
<thead>
<tr>
<th>group</th>
<th>intervals</th>
<th>0-6mon</th>
<th>6-12mon</th>
<th>12-18mon</th>
<th>0-18 mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>lingualized occlusion group(GI)</td>
<td>Mean</td>
<td>0.27mm</td>
<td>0.31mm</td>
<td>0.34mm</td>
<td>0.92 mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.067</td>
<td>0.074</td>
<td>0.089</td>
<td>0.108</td>
</tr>
<tr>
<td>linear occlusion group(GII)</td>
<td>Mean</td>
<td>0.16mm</td>
<td>0.24mm</td>
<td>0.28mm</td>
<td>0.68mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.089</td>
<td>0.114</td>
<td>0.148</td>
<td>0.044</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.03*</td>
<td>0.143</td>
<td>0.232</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

SD = Standard deviation  *significant at p ≤ 0.05
Table (4) shows statistically significant difference in posterior maxillary bone loss at observation periods in the lingualized occlusion group (GI), at (0-6 month, 6-12 month, 12-18 month and 0-18 month). While the least was the linear occlusion group (GII) as the mean of difference in posterior maxillary bone loss at observation periods.

Statistically there was significant difference between (GII) & (GI) from (0-6 month & from 0-18 month) at p≤0.05. While, Statistically there was no significant difference between (GII) & (GI) from (6-12 month & from 12-18 month). (p≤0.05)

**Table (4)** Mean of difference in posterior maxillary bone loss between the two groups

<table>
<thead>
<tr>
<th>group</th>
<th>intervals</th>
<th>0-6 mon</th>
<th>6-12mon</th>
<th>12-18 mon</th>
<th>0-18 mon</th>
</tr>
</thead>
<tbody>
<tr>
<td>lingualized occlusion group (GI)</td>
<td>Mean</td>
<td>0.32mm</td>
<td>0.26mm</td>
<td>0.18mm</td>
<td>0.76 mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.164</td>
<td>0.089</td>
<td>0.084</td>
<td>0.114</td>
</tr>
<tr>
<td>linear occlusion group (GII)</td>
<td>Mean</td>
<td>0.12mm</td>
<td>0.26mm</td>
<td>0.18mm</td>
<td>0.56mm</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>0.084</td>
<td>0.089</td>
<td>0.084</td>
<td>0.207</td>
</tr>
<tr>
<td>p</td>
<td></td>
<td>0.025*</td>
<td>1</td>
<td>1</td>
<td>0.045*</td>
</tr>
</tbody>
</table>

*SD = Standard deviation   *significant at p≤0.05

**DISCUSSION**

All selected patients were males because statistically significant association between mandibular bone density values in women (hormonal factor, strength of masticatory muscles) influence the degree of bone mineralization in mandible. Age-related bone loss is more common in women than in men, particularly in post-menopausal period, which likely reflects the pathological process of osteoporosis. *Solar et al.,(1994)* *(10)*

The opposing maxillary arch was selected to be completely edentulous and complete upper denture were constructed to stabilize the amount of force applied to the lower overdenture and to avoid the possible effect of opposing dentition on the amount of bone resorption. *Jacobs et al.,(1993)* *(9)*

The selected lingualized occlusal concept that eliminates the buccal cusp contact in centric and eccentric excursions together with reducing cuspal incline provide wide occlusal freedom and minimize the amount of horizontal and lateral force transmitted to the implant. Such forces magnify the amount of tension and shear to the implant crystal bone and increase the risk of bone resorption around the implant. *Becker et al.,(1977)* *(18)*

The selected lineal occlusion concept, the masticatory surface of the mandibular posterior teeth have a straight, long narrow occlusal form to provide articulating line with the opposing monoplane teeth. This concept minimizes food penetration, reduces lateral component of force against denture-base, and reduces the fractional resistance and simplifies occlusal adjustment. There is no change in location of contact during lateral movement; therefore the direction of force remains fairly constant. *Gronas & Staut, (1974)* *(11)*

Placement of implants anterior to the mental foramina allowed the inferior cortex to be engaged by the tip of the implant, increasing the primary stability and improving the osseointegration and avoiding the risk of damaging the mental branch of inferior alveolar nerve. *Cornell & John, (2006)* *(4)*

The recent finding of researches demonstrate highly predictable osseointegration with immediate loaded implant both clinically and histologically as it provide
good survival and peri-implant health similar to that obtained in delayed loading. In contrast this method shortens dental rehabilitation times with satisfaction of patients. \cite{Naito2005} Non significant difference between linear and lingualized occlusal concepts groups and within each group during the follow up periods in anterior and posterior mandibular bone loss may be due to, that the implants have a significant positive influence on increasing denture stability which may limit lateral forces placed on residual bone so, help in maintaining the alveolar bone. Evidence indicates that physiological residual ridge resorption occurs in the anterior edentulous mandible at a rate 4 times greater than bone resorption occurring in the same location when dental implants have been used. \cite{Burns2000} 

The significant difference between mean difference in bone loss in the maxilla between linear and lingualized occlusal concepts groups during the follow up, may be attributed to that the residual ridge carry the total load and poorer bone quality in the maxilla. The anterior mandible has the densest bone, followed by the posterior mandible, anterior maxilla, and posterior maxilla. \cite{Sahin2002} 

The non significant increase in mean bone loss in anterior and posterior maxilla within each group during the follow up periods may be due to, less displacing forces transmitted to the upper denture by the increased retention afforded to the lower denture by the mandibular implants. \cite{Davies2001} 

Improved of the tissue health and reduced annual residual ridge resorption in supporting tissues of prostheses that oppose a mandibular implant overdenture had been documented. More stable occlusion provides a better distribution of occlusal forces and protects the maxillary anterior edentulous ridge. \cite{Burns2000} 

Restoring the anterior teeth with no contacts in maximum intercuspation and providing posterior contacts in eccentric occlusion may minimize loading the edentulous anterior maxillary segment and thereby reduce bone loss. \cite{Denissen1993} 

## CONCLUSION

Based on the results of this study, it can be concluded that:

Linear occlusal scheme showed the least bone reduction in maxillary and mandibular residual alveolar ridge, so that it is preferred in the attempt to minimize the harmful effect of horizontal forces transmitted to the residual alveolar ridge.

## REFERENCES


12. Naito T: Immediate loading of dental implants in selected cases may provide similar success rates as compared with delayed loading. Journal of Evidence Based Dental Practice. 2005, 5: 213
