ASDJ
AINSHAMS DENTAL JOURNAL

Print ISSN 1110-7642
Online ISSN 2735-5039

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

Effect of Resilient Soft Liner and Clip Attachments on Peri-Implant Tissue in Splinted Mini-Implant Retained Mandibular Overdentures

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Abstract

Objective: The aim of this study was to radiographically compare and evaluate, the effects of resilient liner and clip attachments on peri implant bone height change of mandibular overdentures retained by splinted mini implants using Cone-beam computed tomography (CBCT).

Materials and Methods: Fourteen completely edentulous patients were selected to participate in this study. Selected patients were divided randomly into two equal groups of seven patients each: Group I: received a mandibular overdenture supported by four mini implants in the interforaminal region of splinted by a cemented bar and retained by clip attachment. Group II: a mandibular overdenture supported by four mini implants in the interforaminal region of splinted by a cemented bar and retained by resilient soft-liner material. Implants marginal bone and residual ridge evaluation was done at the time of denture insertion, six months, and 12 months.

Results: At the end of follow up period, there was statistically significant difference in the marginal bone height changes as group II (bar with soft liner attachment) showed significantly lower marginal bone height changes around the mini implants compared to group I (bar with clip attachment) but showed higher posterior supporting bone height resorption.

Conclusion: Within the limitation of this study, it could be concluded that Splinting of mini implants with a rigid superstructure to retain lower mandibular overdenture offers successful results over 1-year period. Using soft liner with bar offers less marginal bone loss around the mini implants compared to clip attachment but with more posterior residual bone height loss.

Keywords: mini-implants, splinting, soft-liner attachments, clip attachments, peri-implant

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INTRODUCTION

Implant-retained prostheses have been considered as a common treatment modality associated with high success and survival rates, in addition to increased patient satisfaction. However, multiple risk factors were reported to have an effect on the outcome of osseointegrated implants. Such factors include peri-implant bone quantity and quality, medically compromised patients, osteoporosis, drug consumption and smoking.

Smoking in its various forms whether; cigarette, pipe, cigar smoking or smokeless tobacco, has been proven to cause detrimental effects on the oral health ranging from harmless stains, halitosis, alterations in taste sensations to serious major oral diseases such as oral precancerous and cancer lesions.1,2 Periodontal breakdown was also reported by different studies1,3 including; periodontal pockets, attachment loss, alveolar bone loss, gingival recession, furcation defects and subsequent tooth loss. The junctional peri-implant epithelium shows high permeability to nicotine and other exogenous substances, which are therefore present in high concentrations at the bone-implant interface. These substances negatively affect wound closure, angiogenesis and osteogenesis.4

Evidence regarding the effect of smoking on implant failure is, however, still controversial. Unfortunately, previous systematic reviews (SRs)5,6 did not resolve this debate, or even reach a consensus to decide for placing implants in smokers. There were many limitations in those reviews, since they were mostly based on retrospective studies with multiple confounders and different classifications of smoking regarding the frequency and duration of smoking. Therefore, all these factors decrease the creditability and applicability of their findings.

Hence, it seemed necessary to conduct this SR to clarify the effect of smoking on implant therapy, while including prospective studies only and restricting the confounders.

Materials and Methods

Patients Selection:

Fourteen patients were selected from the out-patient clinic of the Prosthodontic Department, faculty of Dentistry, Ain Shams University according to the following criteria:

Inclusion Criteria: Ages range between 50 – 60 years, Patients had completely edentulous arches with the last extraction was done at least 6 months before implants placement, Normal maxilla-mandibular relationship and sufficient inter arch distance, Mandibular arch had a minimum width of 5 mm, and not less than 12 mm height, Patients with good oral hygiene.

Exclusion Criteria: Patients with TMJ disorders, Patients undergoing radiotherapy or chemotherapy, Patients with systemic diseases affecting the bone, Vulnerable groups (mental disorders, patients not capable of decision making, narcotic drug addicts), Patients with defect or bone pathology in the anterior interforaminal area of the mandible, Uncooperative patients who have no understanding of the need for a regular follow up.

Pre-surgical Radiographic Evaluation: A panoramic radiograph was made to:

- Ensure the absence of any pathologic lesion or remaining roots in the mandibular arch.
- Assess the bone quality of the mandibular alveolar ridge, bone trabeculae and inter-trabecular spaces.
- Locate the position of mental foramina and evaluate available bone height from crest of the ridge to inferior border of the mandible.

Primary prosthetic phase:

All patients were rehabilitated by the same procedure; by construction of a complete denture for the maxillary and the mandibular arches for all patients by the conventional procedures. The lower denture was then duplicated to construct clear stent to be used in primary radiographic evaluation after adding 4 radiopaque gutta percha markers placed between the centrals and laterals and between laterals and canines bilaterally and then during implants insertion for marking the approximate osteotomy sites.

Secondary radiographic examination:

A CBCT radiograph was made for the mandibular arch using previously constructed clear acrylic stent with radio-opaque gutta percha markers to assess the osteotomy sites of the implants and determine the height and width of the anterior mandible.

Grouping of Patients: Selected patients were divided randomly into two equal groups of seven patients each:

Group I: Seven patients received a complete denture for the maxillary arch and a mandibular overdenture supported by four mini implants in the anterior interforaminal region of the mandible splinted by a cemented bar and retained by clip attachment.

Group II: Seven patients received a complete denture for the maxillary arch and a mandibular overdenture supported by four mini implants in the anterior interforaminal region of the mandible splinted by a cemented bar and retained by chair side resilient soft-liner material.

Implant selection: Four one-piece screw type mini implants[1] with rectangular abutment were selected with 2.5mm in diameter and 10mm in length.

Radiographic stent modification:

Radiographic stent was modified. Drilling holes were made equidistant form each other in the clear radiographic stent at the desired osteotomy sites aided by a caliper

Surgical procedure: Using the modified radiographic stent, the pilot drill was driven through the holes in the stent to mark the desired locations of the implants. Crestal incision with vertical releasing incision is made with slight flap reflection to allow for proper plateauing of the osteotomy site if needed before drilling. Drilling was made starting with the pilot drill and ends using a 2mm drill to complete the osteotomy.

Flexible metallic surgical guide[2] with a 2mm in diameter positioning pin was placed in the first osteotomy site to aid in the preparation of the other osteotomy sits medial and lateral to it and to insure parallelism of the drills during drilling. Fig (1)

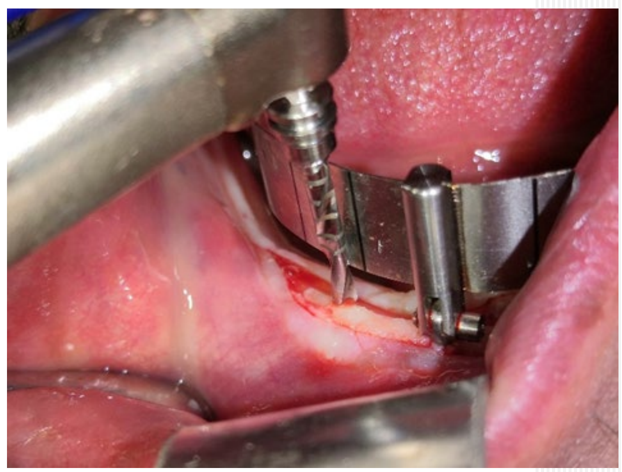

Fig 1: Drilling guided by JD guide

After the completion of each osteotomy site, parallelism was checked and then a 2.5mm diameter mini implant was screwed in the 2mm diameter osteotomy site in self-tapping technique. The full length of the abutment head protruded from the mucosa

DURA-VIT™ MINI implant system, B&B Dental [1] Implant Company, Italy

JD Guide, JDental Care s.r.l, Italy[2]

after mini-implant insertion, while no thread sections were visible.

Implants locations: In both groups the four mini implants were placed in the interforaminal region at equidistance form each other as possible.

Secondary prosthetic phase: After soft tissue healing and suture removal, soft tissue collar around the abutments was evaluated and impressions were made using one step impression technique with heavy consistency PVS[3] and light body PVS[4] for the construction of the bar splint. Castable bars[5] were used for the construction of the attachment systems for both groups. Bars then were waxed, sprued and casted in metal custom made bars the conventional way using Co-Cr dental alloy. The bars were finished and polished the conventional way then tried in the patients' mouth and cemented with self-adhesive resin cement[6]. Fig (2)

Fig 2: Bar after cementation

In group I: For the pick-up phase, a little amount of light-cured dam material was employed to block under and around the bar. Direct pick up technique using auto-polymerizing acrylic resin was made for clip attachment pick up. Fig (3)

Fig 3: Picked up clip attachments for group I

In group II: Bar cementation and undercuts blocking were done the same way as group I. Soft liner material[7] was injected in the trimmed bar depression in the denture and inserted in the patient's mouth until complete setting. Fig (4)

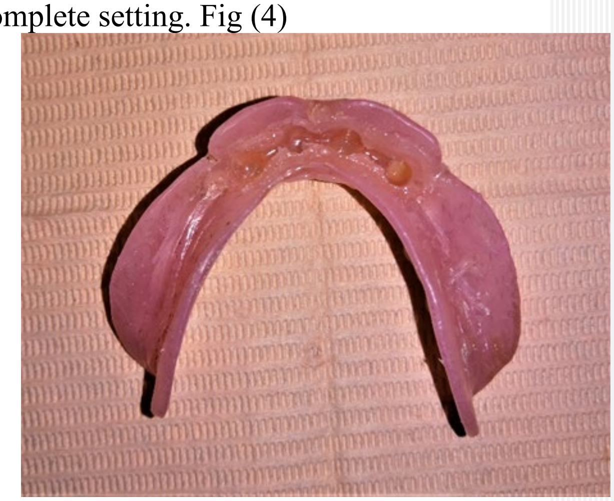

Fig 4: Final soft-liner attachment

Patient's evaluation: Patients were frequently recalled for inspection and post insertion adjustments. Follow up visits were scheduled at time of denture insertion six, and twelve months after denture insertion for making radiographic evaluation of the peri-

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[3] Detaseal® hydroflow soft2 putty, DETAX GmbH & Co. KG, Germany.
[4] Detaseal® hydroflow Xlite, DETAX GmbH & Co. KG, Germany.
[5] OT Bar Multiuse version B, Rhein83 Dental, Italy
[6] Breeze™ Self-Adhesive Resin Cement, Pentron, USA.
[7] Mollosil® plus, DETAX GmbH & Co. KG, Germany.

implant marginal bone and posterior supporting bone height changes.

Radiographic evaluation: The mesial, distal, buccal and lingual marginal bone heights around the implants together with the supporting bone at the lower first molar location, were evaluated using the linear measurement system of CBCT software[8] supplied by the cone beam computed tomography (CBCT)[9].

Statistical Analysis: Data were collected, tabulated, and statistically analyzed using Microsoft Excel ® 2016[10], Statistical Package for Social Science (SPSS)® Ver. 24[11]. and Minitab ® statistical software Ver. 16[12]. Data were revealed as mean difference (mm) and standard deviation. Exploration of the given data was performed using Shapiro-Wilk test and Kolmogorov-Smirnov test for normality. One Way ANOVA test was used to compare between mean difference (mm) of bone loss in different surfaces of implant, followed by Tukey`s post hok test for multiple comparisons.

Results:

I. Comparison between different axial surfaces regarding bone changes during different time intervals in group I & II:

Comparison between group I & II regarding bone changes during different intervals was performed by using Independent t-test as P < 0.05 which is presented in table (1)

.

Table (1): Comparison between group I and group II regarding bone changes at different interval in buccal, lingual, mesial, and distal surfaces

	(n=28)	Group I		Group II		P value
		MD	SD	MD	SD	
Zero – 6 months	Buccal	0.675	0.024	0.663	0.014	0.011*
	Lingual	0.75	0.07	0.410	0.129	0.0001*
	Mesial	0.688	0.019	0.575	0.151	0.0002*
	Distal	0.688	0.002	0.613	0.052	0.0001*
6 – 12 months	Buccal	0.4	0.049	0.363	0.038	0.002*
	Lingual	0.437	0.053	0.351	0.046	0.0001*
	Mesial	0.463	0.023	0.438	0.038	0.004*
	Distal	0.425	0.037	0.362	0.04	0.0001*
Zero – 12 months	Buccal	1.075	0.062	1.026	0.094	0.025*
	Lingual	1.187	0.024	0.863	0.076	0.0001*
	Mesial	1.151	0.056	1.013	0.127	0.0001*
	Distal	1.113	0.039	0.975	0.015	0.0001*

Planmeca Romexis Viewer, Ver 6.1.0.997[8]
Planmeca ProMax® 3D Classic, PLANMECA OY, [9] Finland.

Microsoft Cooperation, USA.[10]
IBM Product, USA.[11]
Minitab LLC, USA.[12]

There was statistically significant difference (P < 0.05) in the mean difference of marginal bone loss around the buccal, lingual, mesial and distal aspects of the mini dental implants of group I (Bar with clip attachment) and group II (Bar with soft liner attachment) in all time intervals. group II showed significantly lower marginal bone height changes compared to group I.

II. Comparison between overall (the average of all surfaces) & 1st molar area in group I & II:

Comparison between group I & II regarding bone changes during different intervals regarding overall (average of all surfaces) and residual ridge was performed by using Independent t-test as P < 0.05 which is presented in table (2).

Table (2): Comparison between group I and group II regarding bone changes at different interval in overall & residual ridge

		Group I		Group II		P value
		MD	SD	MD	SD	
Zero – 6 months	Overall (n=112)	0.700	0.034	0.565	0.049	0.0001*
	Residual ridge (n=14)	0.442	0.041	0.525	0.037	0.0001*
6 -12 months	Overall (n=112)	0.431	0.026	0.378	0.052	0.0001*
	Residual ridge (n=14)	0.500	0.112	0.700	0.193	0.002*
Zero – 12 months	Overall (n=112)	1.132	0.048	0.969	0.074	0.0001*
	Residual ridge (n=14)	0.942	0.514	1.225	0.230	0.013*

There was statistically significant difference in the mean difference of marginal bone height in the average of all surfaces of the mini dental implants of group I (Bar with clip attachment) and group II (Bar with soft liner attachment) in all time intervals. group II showed significantly lower marginal bone height changes compared to group I.

Meanwhile, there was statistically significant difference in the mean difference of marginal bone height at the 1st molar area of group I (Bar with clip attachment) and group II (Bar with soft liner attachment) in all time intervals. group I showed significantly lower residual ridge height changes compared to group II.

III. Comparison between group I & II regarding central and peripheral implants:

Comparison between central and peripheral implants in both groups during all intervals was performed by using Independent t-test as P<0.05 which is presented in table (3).

Table (3): Comparison between group I and group II regarding overall bone changes in both central & peripheral implants:

	(n=56)	Group I		Group II		P value
		MD	SD	MD	SD	
Zero – 6 months	Peripheral	0.756	0.005	0.631	0.092	0.0001*
Zero – 6 months	Central	0.644	0.059	0.499	0.137	0.0001*
Zero – 6 months	P value	0.0001*		0.0001*		
6 months – 12 months	Peripheral	0.45	0.025	0.391	0.055	0.0001*
6 months – 12 months	Central	0.41	0.021	0.364	0.026	0.0001*
6 months – 12 months	P value	0.0001*		0.0001*		
Zero – 12 months	Peripheral	1.19	0.02	1.01	0.228	0.0001*
Zero – 12 months	Central	1.05	0.037	0.92	0.288	0.0011*
Zero – 12 months	P value	0.0001*		0.0001*		

Statistical analysis of the data revealed significant increase in the amount of bone loss at the peripheral implants compared to the central implants in both groups. The data also showed that when comparing peripheral implants in both groups, it revealed significant increase in the amount of bone loss in group I. Same result was revealed when comparing central implants in both groups.

Discussion:

In this study patients were precisely selected and thoroughly examined in an attempt to reduce human variables and eliminate any factor or habit that might adversely affect the results of this study. This was done using comprehensive medical history, and clinical[10].

Pre-operative cone beam computed tomography with the aid of clear acrylic stent with radiopaque gutta percha markers was used to determine the position and the desired angulations of the mini-implants, as anatomy and bone quality affect the outcome and ease of surgical placement of mini implants[11].

The choice of the interforaminal region was advocated due to the absence of any vital structures that may be injured, also because immediately loaded mini implant should intimately engage dense cortical bone at their apical and crestal aspect to exhibit primary stability needed for success of osseointegration[12].

In this study mini-implants rather than standard diameter implants were used to support and retain lower denture without any need for bone augmentation surgery and its possible complications[13].

The stresses encountered by individual mini-implants are reduced when numerous mini-implants are used to maintain detachable prostheses. Cyclic occlusal stress may exhaust the small-diameter implant neck to the point of fracture if too few mini-implants are employed[14]. So, in this study 4 mini implants were used in the anterior intraforaminal region. Several studies[15-17] revealed that the use of four mini implants installed in the interforaminal region fulfills the criteria of implant success as indicated by the measured amount of bone loss.

Most mini-implants feature a one-piece construction. In this study implants with straight rectangular abutments were used for proper construction of splint bar attachment[18].

The Implant length used was the same in all cases (10 mm), as different implant length with different available bone supporting them may influence the pressure per unit area in the supporting bone which may be reflected on the results[19]. Screw type mini-implant was used in this study as its geometry enhance better initial stability and better bone-implant interface as well as better transmission of compressive forces to the bone which enhance osseointegration[20].

Stresses are most evenly distributed when occlusal forces are directed at the center of the implant through its long axis[21]. As a result, it was critical to prevent inclinations in both the labiolingual and mesio-distal directions, which was done by using a flexible metallic surgical guide and inserting paralleling instruments often during the drilling process. This was also done to eliminate problems that may arise during the prosthetic stage, such as difficulty in obtaining an insertion route and early attachment component wear[22].

The immediate - delayed implant loading protocol -after suture removal was followed in this study as the results of several studies revealed no significant difference between immediate and delayed implant loading by mandibular over dentures[23].

Impressions were made using one step impression technique with heavy consistency PVS and light body PVS for the construction of the bar splint due to its favorable accuracy on die construction[24]. Bar attachment was used in this study for splinting the mini implants, as splinting provides better stress distribution[8] and better retention qualities[25]. Co-Cr was used in bar construction due to its mechanical properties, i.e. stiffness (high elastic modulus), dimension stability and corrosion resistance[26].

The direct pickup technique was preferred over the indirect technique in incorporating the clip attachments to avoid the possible discrepancies that may occur if indirect technique was used[27]. Light cured dam material was placed under the bar for blocking out any undercuts that acrylic may flow into and prevent removal of the denture after loading procedure.

Soft liner material was chosen in this study as an attachment with the splinting bar due to its acceptable retentive qualities, better soft tissue coverage around the bar attachment, and better stress distribution[28].

In this study peri-implant bone height change was evaluated. The radiographic evaluation was performed at the time of denture insertion, six, and twelve months after denture insertion and was compared with the baseline to allow for a more accurate assessment of bone changes.

Cone-beam computed tomography was used in this study to evaluate bone changes as it provides no superimpositions, minimal radiation doses, and the ability to verify in rebuilt pictures created by graphic computation software. CBCT Software also provided useful tools for identifying landmarks, taking quantitative measurements, and segmenting area of interest in three dimensions (3D)[29].

In group I and group II, average marginal bone loss around the mini implants at the end of 12 months follow up period were 1.1 and 0.9 respectively. The long-term success of dental implants is related to their early osseointegration. The success criteria for implants are no radiolucency around the implant, no mobility and no suppuration or pain. Also, marginal bone resorption adjacent to implants of less than 1.2 mm at the end of 12 months and 0.1 mm annually was reported in longitudinal clinical studies[30].

The significant decrease of marginal bone height surrounding the Mini implants in all aspects (buccal, lingual, mesial and distal) in both groups was found throughout all time intervals during this study. This bone reduction might be due to surgical trauma, bone osteotomy and healing process. This also could be attributed to the micro-damage accumulation occurring in bone after implant placement[31]. Further reduction of the bone height till the end of the study period might be due to mechanical factors acting on the implants as the loading and forces of mastication[31].

It has been observed that the maximum calculated mean of marginal bone loss for both groups was evident at the six-month interval and progressed slowly after. According to Cochran et al.[32] and Fernández et al.[33], peri-implant bone remodeling after implant placement is more accentuated in the first 6 months after surgery. Hartman et al[34], considered most bone loss to occur in the first 6 months, followed by gradual stabilization till the end of follow up period.

Comparing the marginal bone loss in both groups, it was found that resilient liner attachment had significantly decreased marginal bone losses in mesial, distal, buccal, and lingual aspects of all implants with advance of time when compared with clip attachment. This may be explained through the shock-absorbing ability of soft liner reduces the stress applied to the implants[35], which in turn reduces peri-implant bone loss[28].

The data in this study revealed when comparing the marginal bone loss around peripheral and central implants in each group a significant increase in the amount of bone loss at the peripheral implants compared to the central implants in both groups. This could be related to high stress on the peripheral implants. Naggar et al.[36] concluded in their study that stresses over the peripheral implants are higher than central implants and demonstrated the highest peri implant strain. Sertgöz and Güvener[37] stated that in implant supported prothesis, maximum stresses are concentrated at the most distal bone/implant interface, located on the loaded side of the terminal implant.

Considering the residual ridge, this study showed continuous decrease in the ridge height at the first molar area throughout the follow up period. According to N Tymstra et al.[38] Resorption of the mandibular posterior residual ridge occurred regardless of whether the patient wore an implant-retained mandibular overdenture or a conventional mandibular denture.

When comparing group I and group II regarding bone loss in residual ridge throughout the follow up period, group II with the soft liner attachment showed more residual ridge resorption than group I with the clip attachment. According to Elsyad et al.[39], Resilient liner attachment for bar/implant-retained overdentures is associated with greater posterior mandibular ridge resorption compared to clip attachments after 7 years. He stated in his study that the increased posterior mandibular ridge resorption with resilient liner-retained overdentures compared to clip-retained overdentures may be due to these liners enhancing ridge loading with twist-free load transmission to the implants compared to clip attachment which provide less movement and more stability to the prosthesis.

CONCLUSION

Within the limitation of this study, it could be concluded that:

1. Splinting mini implants with a rigid superstructure to retain lower mandibular overdenture offers successful results over 1-year period.
2. Using soft liner with bar offers less marginal bone loss around the mini implants than compared to clip attachment but more posterior residual bone height loss.

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