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CLINICAL RESEARCH

Effect of mucostatic and selective pressure impression techniques on residual ridge resorption in individuals with different bone mineral densities: A prospective clinical pilot study

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ABSTRACT

Statement of problem. Although different impression techniques have been advocated for complete denture prosthodontics, objective studies that predict their effect on alveolar bone resorption are lacking.

Purpose. The purpose of this prospective clinical pilot study was to objectively evaluate the effect of complete dentures fabricated by different impression techniques on mandibular residual ridge resorption in individuals with different bone mineral density.

Material and methods. Ninety-six participants with edentulism, selected according to inclusion criteria, underwent bone mineral density assessment and were divided into normal, osteopenic, and osteoporotic groups. Half of the participants in each group were provided with dentures fabricated by selective pressure impression technique (subgroup SIT), and the other half were provided with dentures fabricated by mucostatic impression technique (subgroup MIT). Computed tomographic scans of the mandible were made at denture delivery and 1 year after prosthesis use to assess alveolar bone height and width difference at marked locations at and after denture delivery. The data obtained were analyzed with the Student *t* test (α=.05).

Results. Significantly less reduction in mandibular ridge height and width was found in the MIT versus the SIT subgroups in both osteopenic and osteoporotic participants (P<.05). No significant subgroup difference was found for normal bone mineral density group, although resorption increased in height and width for the SIT subgroup.

Conclusions. Mandibular residual ridge resorption was reduced for dentures fabricated using the mucostatic impression technique compared with the selective pressure impression technique in individuals with diminished bone density. (J Prosthet Dent 2019;121:90-4)

Edentulism is an important public health issue for the elderly.[1] Although the prevalence of edentulism is decreasing in developed countries, many individuals still need prosthodontic treatment worldwide. In India, an estimated 11.7% are edentulous.[2] These patients are normally rehabilitated with complete dentures supported by residual ridges. Masticatory function with dentures generates forces which are transmitted through the denture base onto the underlying residual ridge.[3,4] The inherent capacity of the bone to bear these transmitted stresses depends on its quantity and quality (constitution and microarchitecture), which varies in different regions of the jaws.[5]

Peak bone mass is usually attained by the age of 35 to 40 years in healthy humans, after which bone mass depletion occurs with varying intensity, accelerating in women after menopause, but less so in men of a similar age. Bone mass is decreased in individuals diagnosed with conditions such as osteoporosis. Most individuals seeking prosthodontic rehabilitation, especially those requiring complete dentures are of an age where bone mass depletion has started, which further diminishes the ability of the bone to withstand masticatory forces.[6,7]

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Clinical Implications

Complete dentures for patients with osteopenia or osteoporosis could be fabricated using a minimal pressure impression technique to decrease residual ridge resorption, thereby improving the overall prognosis and quality of life.

Therefore, knowing the condition of the bone before planning a prosthetic rehabilitation is essential. Altered hormonal status, sex, vitamin metabolism, systemic disorders, and pathological and congenital conditions play an important role in determining the quality of the alveolar ridge,[8] along with bone mineral density (BMD), which is an independent factor that can be associated with the rate of residual ridge resorption (RRR).[9-11]

Three techniques have been described for making impressions of edentulous arches in relation to the pressures applied to anatomic areas: the mucostatic impression technique (minimal pressure technique), functional impression technique (pressure technique), and semifunctional impression technique (selective pressure technique).[12] Each technique has its advantages and disadvantages. The selective pressure impression technique, as advocated by Boucher,[13] has been commonly used and records predefined stress-bearing areas under pressure and nonstress bearing areas under minimum pressure. Relief is provided in nonstress bearing areas to maintain tissue health.[13] In the mucostatic, nonpressure, or minimal pressure technique, all denture bearing areas are recorded in a nondisplaced, passive state under minimal pressure, either by providing consistent relief or by using a fluid impression material. This technique captures only nonmovable tissues and the denture relies on interfacial surface tension for retention.[13,14] Proponents of different techniques have reported varying degrees of RRR.[13]

The authors are unaware of a study that has objectively determined the effect of different impression techniques on RRR in patients with different BMD status. Therefore, this study was conducted to determine the effect of complete dentures fabricated using different impression techniques on mandibular RRR in participants with different BMD status. The null hypothesis was that no difference will be found in mandibular RRR with selective pressure or mucostatic impression techniques in different BMD groups.

MATERIAL AND METHODS

This prospective 2-year study was carried out in the Department of Prosthodontics of Saraswati Dental College, Lucknow after obtaining the approval of the institutional ethical committee. The inclusion criterion was edentulous men between 40 and 70 years.[7] The exclusion criteria included participants with a history of smoking or alcohol dependence, oral, metabolic, skeletal, hepatic, renal, or endocrine disease, or medications for these disorders. Based on these criteria, 102 participants were included in the study. Six participants were lost to follow-up. Informed consent was obtained from each participant.

All participants were assessed for BMD with a bone densitometry system (Lunar DPX DXA System analysis v11.40; GE Healthcare). Participants were divided on the basis of T scores (as per World Health Organization guidelines) as follows: group NO (normal): edentulous participants with BMD values/T score greater than -1 (n=36); group ON (osteopenic): edentulous participants having BMD values/T score between -1 to -2.5 T score (n=32); and group OR (osteoporotic): edentulous participants having BMD values/T score less than -2.5 T score (n=28).[15]

In each group, the participants were randomly (software generated 1:1 sequence) divided into 2 subgroups. For subgroup SIT, dentures were fabricated using the selective pressure impression technique[13] and for subgroup MIT, the mucostatic impression technique was used. To make preliminary impressions for the SIT subgroup, rimmed edentulous metal stock trays (Rim-Lock Impression Trays; Dentsply Sirona) were selected that allowed for an approximately 6 mm thickness of impression material and impressions made with irreversible hydrocolloid (Zelgan; Dentsply Sirona). A 1-mm-thick wax spacer (MAARC Spacer Wax; Shiva Products) was placed on the entire mandibular basal seat area on the preliminary cast, except the buccal shelf area and retromylohyoid spaces,[13] and custom trays were made with autopolymerizing resin (RR Cold Cure; DPI). Border molding was done with low-fusing modeling plastic impression compound (DPI Pinnacle Tracing sticks; DPI), and definitive impressions were made with zinc oxide eugenol impression paste (DPI Impression Paste; DPI).

Preliminary impressions for the MIT subgroup were similar to those for the SIT subgroup. A 2-mm-thick wax spacer (MAARC Spacer Wax; Shiva Products) was placed on the entire mandibular basal seat area of the preliminary cast and custom trays made with autopolymerizing resin (RR Cold Cure; DPI). No border molding was done, and definitive impressions were made with irreversible hydrocolloid (Zelgan; Dentsply Sirona) after complete spacer removal.

A traditional method[16] of denture fabrication was used for all participants by the same clinicians (T.A., G.A.). The method included a facebow record and horizontal and vertical jaw relation records to mount casts on a semiadjustable articulator (Hanau Wide-Vue; Whip Mix Corp), semi-anatomic polymethyl methacrylate resin teeth (Ruthinium Dental teeth set-Acryrock; Deccan Dental Depot Pvt Ltd) arranged in a balanced occlusion,

compression molding polymerization, and conventional delivery and follow-up appointments. Radiopaque markers were incorporated in the mandibular dentures between the central incisors and inferior to the first molars (Fig. 1). At the time of denture delivery, high resolution panoramic computed tomographic scans (SOMATOM Definition AS; Siemens Healthcare GmbH) of the mandible were obtained with the participant in a supine position. The position of the gantry was standardized for all scans.

After 1 year of denture use, a new computed tomographic scan was made. Alveolar bone height and width was assessed tomographically at baseline and after 1 year of denture use at the marked locations (at same slice number for a particular participant). Mean values of residual ridge height and width resorption for each subgroup were calculated from the 3 readings obtained at the interincisor and molar areas (where the radiopaque markers had been placed). The values were combined, calculated, and analyzed for the 2 subgroups in each group. Before and after comparisons were made with statistical software (IBM SPSS Statistics, v23.0; IBM Corp). The Student *t* test was used to make intragroup comparisons for this single-factor study (α=.05).

RESULTS

The data are presented in Table 1. No statistically significant differences (P>.05) in mandibular residual ridge height or width were found between subgroups MIT and SIT for all 3BMD groups (NO, ON, and OR). Also, the reduction in mandibular height and width for subgroup MIT versus SIT in the NO group was not significant (P>.05). However, mandibular height and width reduction was significantly greater for SIT subgroup compared with the MIT subgroup in ON (P<.001 for both height and width) and OR participants (P=.014 for height, P<.001 for width).

DISCUSSION

The results obtained from this study led to rejection of the null hypothesis as a difference was found in mandibular RRR with different impression techniques in individuals with different BMDs.

Considerable individual variation in the degree of RRR has confounded studies on factors that may influence the progress of such resorption.[17] The etiology of RRR is still not fully understood; however, studies have described a correlation of 63 different factors and ridge resorption.[18] Despite the listing of many factors responsible for RRR, a single dominant factor has not yet been determined.

In the absence of teeth, masticatory forces transferred to residual ridges either directly or indirectly by removable prostheses accelerate RRR. Whatever the etiological factor responsible for RRR, its effect on the prognosis of complete dentures is always detrimental. Some studies have shown that denture wearing is one of the factors associated with increased residual alveolar bone loss.[17,18] The number of mandibular dentures worn can be correlated to the severity of alveolar bone loss.[12] Continuous RRR results in irreversible progressive loss of bone volume, causing poor denture fit, appearance, mastication, and health.

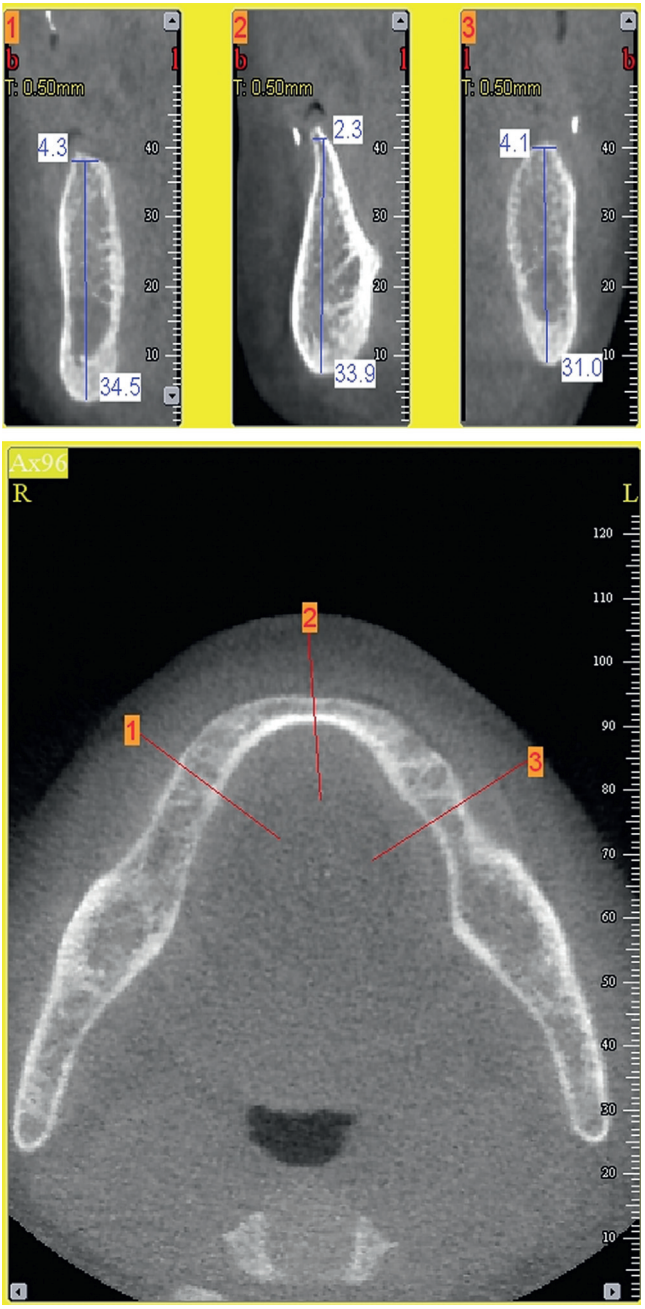

Figure 1. Top, Representative mandibular residual ridge computed tomographic scan. Bottom, Denture radiopaque inserts for site specific height and width measurement.

Table 1. Total and percentage reduction in mandibular residual bone height and width at 1 year

Characteristic	Group NO (N=36)		Group ON (N=32)		Group OR (N=28)		Total (N=96)	
	% Reduction	Mean Reduction ±SD (mm)	% Reduction	Mean Reduction ±SD (mm)	% Reduction	Mean Reduction ±SD (mm)	% Reduction	Mean Reduction ±SD (mm)
Mandibular Height								
MIT	1.08	0.21 ±0.86	1.27	0.25 ±0.50	4.01	0.76 ±1.39	2.12	0.41 ±1.68
SIT	1.60	0.30 ±1.13	2.71	0.53 ±1.43	5.48	0.94 ±1.48	3.19	0.59 ±2.06
T score		1.578		4.164		2.629		3.020
P		.126		<.001		.014		.003
Mandibular Width								
MIT	1.39	0.17 ±1.06	1.21	0.16 ±0.63	4.96	0.62 ±2.00	2.45	0.31 ±2.27
SIT	2.07	0.34 ±1.67	3.62	0.46 ±1.35	8.02	0.92 ±2.36	4.65	0.57 ±3.06
T score		2.764		6.856		4.126		4.304
P		.010		<.001		<.001		<.001

MIT, mucostatic impression technique; NO, normal; ON, osteopenic; OR, osteoporotic; SIT, selective pressure impression technique.

That an individual's BMD status affects RRR has been well established.[7,19] The deleterious effect of RRR on bone increase in patients with low BMD because of depleted bone, deteriorated bony architecture, and alteration in the physiology of osseous proteins makes the bone more prone to injury from mechanical forces.[19]

Although RRR continues throughout the life of a denture wearer; the quality of life for patients with edentulism is improved by optimally supported, stable, and well-retained complete dentures. Factors related to complete denture fabrication and method of use may also affect RRR. Different methods have been introduced for making impressions of edentulous ridges, and their proponents have claimed varying degrees of RRR.[13]

However, the authors are unaware of a study that has objectively illustrated the effect of different impression techniques on RRR in patients with different BMD status. Therefore, this study was conducted to determine the effect of complete dentures fabricated by different impression techniques on mandibular RRR in patients with different BMD status.

In the present study, only men were recruited to exclude the possible variation due to menopausal factors in women. Participants between 40 and 70 years were selected as most of the patients seeking complete denture prosthodontic rehabilitation services in our institution fall in this age range. Upper extremes of age were excluded because of the possible effect of general systemic compromised RRR.

The gold standard noninvasive diagnostic modality for determining skeletal mineral density, energy X-ray absorptiometry (DXA), was used in the present study. Computerized tomography scans (Dentascans) were used for quantitative analysis (residual ridge dimension in mm) of mandibular bone, as it is the best method of visualizing anatomic structures and bone borders.[20]

The results of this study indicate that dentures made with the minimal pressure impression technique decrease residual alveolar ridge resorption in patients with compromised BMD compared with the conventional technique. Hence, strategizing denture fabrication in deference to the quality and quantity of available bone by suitably altering the impression technique is one way to slow bone loss under function and to improve the long-term prognosis of the complete denture service. The conventional selective impression technique may be preferred for participants with normal BMD to improve retention. In patients with osteopenia or osteoporosis, the minimal pressure technique may be a better treatment choice.

To our knowledge, this study is the first to objectively evaluate the effect of 2 different impression techniques on RRR. Limitations of this study include the short observation period of 1 year. Future studies involving a larger sample size and longer follow-up are required to substantiate the results of this pilot study.

CONCLUSIONS

Based on the findings of this prospective clinical pilot study, the following conclusion was drawn:

1. RRR is reduced for dentures fabricated using mucostatic impression technique compared with the selective pressure impression technique in patients with diminished bone density.

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Noteworthy Abstracts of the Current Literature

Early implant failures in edentulous patients: A multivariable regression analysis of 4615 consecutively treated jaws. A retrospective study

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Purpose. To study the incidence of early implant failures in edentulous jaws and to describe the effects of some patient- and implant-related factors on the risk for early implant failures.

Material and methods. The study retrospectively analyzed 4615 edentulous jaws (4067 patients), consecutively treated with dental implants at one referral clinic from 1986 to 2013. Implant failures that occurred from implant surgery up to the first recall examination 1 year after prosthesis insertion were recorded and defined as early implant failures. All removed implants were included as failures. Features of the study group and early implant failure rates were reported. A multivariable logistic regression model was used for analyzing possible associations between clinical factors, and the risk for early implant failures. Implant surfaces were categorized by means of roughness: turned (S_a 0.5-1.0 μm) and moderately rough (S_a 1.0-2.0 μm).

Results. Three hundred twenty-seven patients (344 jaws) were lost to follow-up. Early implant failures occurred in 8.6% of the jaws. In the maxilla there was a significantly higher incidence of early failures compared to the mandible both with turned implants, OR 5.93 (95% CI 4.21; 8.36), and moderately rough implants, OR 2.52 (95% CI 1.19; 5.34). The impact of implant surface roughness was significant in the maxilla with higher incidence of early failures with turned implants, OR 3.51 (95% CI 2.27; 5.42). There was a significant interaction between implant surface and jaw type on early failures (p=0.034). Older age was associated with lower risk for early implant failures, OR 0.9 (95% CI 0.82; 0.99). In total, 63% of the jaws with failure could proceed with the prosthetic treatment without further implant insertions. Twenty-six percent of the early failures occurred after prosthesis insertion and 59% of those could maintain the same prosthesis after implant loss with or without adjustments.

Conclusions. Changing the implant surface from turned to moderately rough decreased the incidence of early implant failures significantly in the maxilla, but not in the mandible. Older age at implant insertion was associated with lower risk for early implant failures in edentulous patients.

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