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NEUTRAL ZONE DENTURES VERSUS CONVENTIONAL DENTURES IN DIVERSE EDENTULOUS PERIODS

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ABSTRACT

The objectives of this study were to compare the arrangement of teeth according to the bone support concept with the neutral zone concept, Evaluate the influence of two arrangement schemes on denture success. A total of 128 patients were equally allocated into two groups, according to period of edentulism. All groups were provided neutral zone and conventional dentures. Post insertion assessment of conventional and neutral zone dentures was compared. Both denture techniques showed satisfactory assessment results in shorter edentulous period. In longer edentulous period, neutral zone dentures showed better assessment results. Arrangement of teeth with neutral zone may improve denture success in patients with prolonged edentulous periods.

Key Words: *Edentulous, Denture, Retention.*

INTRODUCTION

The objectives of any prosthodontic service are to restore the patient to normal function, contour, esthetics, speech and health[1]. Optimum denture stability is difficult to achieve in conventional complete dentures. This problem is more magnified with-in mandibular dentures. The design of prostheses to replace lost teeth and resorbed ridges is largely determined by the position and amount of morphological change in the denture bearing area of the jaws[2]. These changes dictate artificial tooth positions in complete denture patients.

The arrangement of teeth must be physiologically and esthetically acceptable. Dislodging forces, discrepancies in residual ridge, maxillo-mandibular relationships, residual ridge relationships, functional and para-functional mandibular movements, esthetic requirements and preferences of patients are factors governing appropriate tooth arrangements[3].

According to stomatognathic system, natural teeth erupt into the mouth under the influence of muscular environment evolved over the centuries. After the loss of natural teeth, it is difficult to ascertain the exact position due to varying pattern of alveolar bone resorption in different segments.

The concept of "teeth over the residual ridge" is based on the mechanical principle of ensuring stability by directing the forces at right angle to supporting tissues. Mandibular posterior teeth are placed with their central fissures coinciding with a line joining the cuspid tip and the middle of retro molar pad[4]. Bucco-lingually narrow teeth when placed closer to ridge offer additional lever balance[5]. Crests of the residual ridge may be used as a biometric guide. Unfortunately the crests do not remain in same antero-posterior and medio-lateral position. Pietrokoviski and Massler[6] demonstrated that, viewed from the occlusal aspect, the crest of the residual alveolar ridge shifts lingually in maxilla and buccally in mandible. Both arches are resorbed in vertical and horizontal direction. The alveolar ridge crest changes its location in a bucco-lingual direction after resorption[7]. The probable cause of this resorption pattern may be eruptive pathway of teeth, development pattern of alveolar processes or muscular or myodynamic forces. So arrangement of artificial teeth strictly over the crest of residual ridge may accentuate facial deformity, provoke phonetic problems and affect deglutition[8].

Neutral zone may be defined as the space where during function the forces of the lips and cheeks pressing inwards neutralize the forces of the tongue pressing outwards. The neutral zone concept implies acquired muscle control especially by tongue, lips, and cheeks towards denture stability. Advocates of neutral zone agree that lack of favorable leverage is observed when teeth are positioned directly over the ridge[9]. As in this case teeth are not positioned in harmony with the surrounding musculature. By employing neutral zone concept, the dislodging muscle energy can easily become a retentive and stabilizing force[9].

Beresin and Schisser[10] have suggested that denture teeth should be arranged in the neutral zone. After loss of teeth, a potential denture space or void exists within oral cavity. It is bounded by maxilla and soft palate above, by mandible and floor of mouth below, by tongue medially or internally and by muscles and tissue of lips and cheeks laterally or externally[10]. Within the denture space, neutral zone lies.

Some professionals suggest that long period of edentulism modifies the position of neutral zone.[11-13] Studies[14-19] indicate that duration of edentulism influences residual ridge resorption.

This study evaluate the status of patients' acceptability to complete dentures fabricated on the concepts of neutral zone and bone support, in a sample of Pakistani population.

MATERIALS AND METHODS

The study was carried out on edentulous patients, reporting in the Prosthodontics Department, of Lahore Medical and Dental College, Lahore.

One hundred and twenty eight patients were selected by using convenient, non-probability sampling**.** They were randomly allocated into two groups of sixty four each, by using random number tables. Group A had an edentulous period of 6 months to 2 years. Group B had an edentulous period of more than 2 years.

Patients with edentulous period for at least 6 months exhibiting normal range of maximal mouth opening (40-50 mm) and normal temporomandibular joint movements were included. Patient with any intra oral soft tissue or bony pathology and reduced intermaxillary space were excluded from the study. Study design was quasi-experimental intervention study.

Data Collection Procedure

Informed consent was taken from all patients. Patients' demographic data (name, age, sex, address) was noted on proformas. Edentulous period and old denture wearers were confounding variables. The confounding variables were controlled through matching. The steps of procedures and materials used for complete denture construction were kept constant. Allocation into the subgroups was done on the basis of the procedures performed. 50% of group A i.e. group A_1 were provided with dentures constructed, according to the neutral zone concept. While the remaining 50% of group A i.e. Group A_2 were provided with dentures based on the bone support concept. 50% of Group B i.e. group B_1 were provided with dentures fabricated according to the neutral zone concept. The remaining 50% of group B, i.e. B_2 were provided with dentures based on the bone support concept. These groups were matched on age and socioeconomic factors.

All patients were provided with upper and lower complete dentures. The benefits of denture construction through both techniques were explained to the patients.

Primary impressions were recorded in impression compound **(**Kerr impression compound, Kerr Headquarters and Direct Sales Information 1717 West Collins Orange, CA 92867**)**. Custom trays were constructed in autopolymerizing acrylic resin (Vitacrylic, self cure acrylic, Fricke Dental International, Inc. 208 West Ridge RD Villa Park, IL 60181 U.S.A). Secondary impressions were made with eugenol-free Zinc Oxide impression paste (Cavex, Holland BV. P.O. Box 852. 2003 RW Harlem, the Netherlands.) Permanent bases were made in heat cure acrylic resin (Vitacrylic, plain denture acrylic, Fricke Dental International, Inc. 208 West Ridge RD Villa Park, IL 60181 U.S.A). They were evaluated for comfort, retention and stability. Comfort was evaluated by asking the patient about any pain and difficulty in functional movements of oro-facial musculature. Retention was evaluated by asking the patient to relax with his/her tongue at rest. A probe was placed at the lower incisor region. The resistance to upward pressure of the probe and base plate was assessed[20]. Extent of rotation or tilt under finger pressure at premolar or molar areas was noted[21] to evaluate stability. Maxillary occlusal rim was formed in modeling wax (Cavex® Set up Modeling Wax Cavex Holland BV. P.O. Box 852. 2003 RW Harlem, the Netherlands.)

It was adjusted in mouth by foxes plane. This plane determined the antero-posterior plane of occlusion. Upper lip length was used to determine the anterior occlusal plane. Upper lip support, nasolabial angle and facial profile allowed adequate carving of the wax occlusion rim. The inter-pupillary line ensured parallelism of anterior occlusal plane. Orientation relation was recorded by an arbitrary face bow. Phonetic method[22] was employed to determine the maxillo-mandibular vertical relation. Patients were asked to pronounce sibilants.

The neutral zones of mandibular arches were functionally recorded for each patient. Impression compound **(**Kerr impression compound, Kerr Headquarters and Direct Sales Information 1717 West Collins Orange, CA 92867**)** was used to record the neutral zone. Initially a stainless steel vulcanite bur (Acrylic trimmer, Summit Orthodontic Services and Laboratory Products Company P.O. Box 218 343 North Moreland Avenue Munroe Falls, Ohio 44262) was used to roughen the polished surface of mandibular denture base. This aided in retaining the occlusal rim. The composition cake was softened in warm water within a temperature range of 60 -70°C. The softened compound was molded into a roll. It was adapted onto the occlusal surface of the mandibular base plate. The dimensions and inclinations of the composition roll were formed according to the vertical dimension of occlusion of the patient.

Mandibular base plate with occlusal rim was inserted into the patient's mouth. Occlusal rim was heated with an alcohol torch (Bolton dental manufacturing incorporation 50 Goebel Avenue, Camb-

ridge, Ontario Canada N3C 1Z1) to functionally mold the labial and lingual surfaces. Patients were asked to perform smiling, whistling and swallowing movements to record neutral zone during function. Excess compound was displaced on occlusal, labial and lingual surfaces. It was trimmed with the Bard Parker's blade no. 15. The rims were reheated till no composition was displaced occlusally to increase the predetermined occlusal vertical dimension. Rims were finalized to create smooth labial and lingual surfaces.

Centric relation was recorded with bite registration wax (Aluwax Dental Products Company P.O. Box 87, Allendale, MI 49401). Maxillary and mandibular occlusal rims were mounted on a semi-adjustable articulator (Quick Master, Sintec Inc. 350 Concord Lane PO Box 129 E. Wakefield, NH 03830).

Dentures of group A_1 and B_1 were processed according to the neutral zone concept. Plaster of Paris (Jai Durga Plaster Industries) matrices were formed around mandibular articulated casts Impression composition (Kerr impression compound, Kerr Headquarters and Direct Sales Information 1717 West Collins Orange, CA 92867) was removed from the bounded space. Mandibular teeth (Wiedent) were arranged within the space. Maxillary posterior teeth followed the mandibular teeth.

Teeth were arranged according to the center of mandibular ridge crest for Groups A_2 and B_2. A line was marked on the mandibular occlusal rim extending from the tip of canine to the center of retromolar pads. The central fossae of the mandibular teeth coincided with this line. Maxillary palatal cusps interdigitated with the central fossae of the mandibular teeth. Class I molar relation was given.

After complete tooth arrangements, dentures were tried in. Protrusive relation was recorded with bite registration wax (Aluwax Dental Products Company P.O. Box 87, Allendale, MI 49401**)**. Patients were asked to protrude their mandibles and occlude the teeth in protrusive position. Material was allowed to set. The sealed dentures were removed from mouth. This adjusted the articulator for protrusive relations and provided the condylar path. Lateral relation records were calculated from the Hanau's formula.

$$L = \frac{H}{8} + 12$$

Occlusion was bilaterally balanced. The dentures were then tried in the patients' mouths. The procedure was repeated when the trial was not satisfactory. Upper and lower dentures were processed. Complete wax up, pooling carving and festooning was done. Dentures were flasked and dewaxed. Flasks were packed with polymethyl methacrylate acrylic (Vitacrylic, plain denture acrylic, Fricke Dental International, Inc. 208 West Ridge RD Villa Park, IL 60181 U.S.A)). They were bench pressed for 20 minutes.

Flasks were placed in clean water container at room temperature. Dentures were processed at 74° C for approximately 2 hours and then 100°C for approximately 1 hour. Dentures were deflasked, finished and polished. Finished dentures were transferred to articulators. Occlusal adjustment was performed on articulated casts by using articulating paper (Crosstex) and no. 8 round bur (Charles Brungart, Inc.) on a micro-motor (NSK, Japan) hand piece. Final polishing was done. Dentures were inserted into the patients' mouths.

Patients' assessments were done after 3 days, 10 days and 40 days of denture insertion on seven factors. The last assessment was considered significant for the study. This allowed adequate time for denture adaptation. Final outcome of assessment of dentures constructed according to both concepts were compared. All the information charted down on proforma.

The technical quality of mandibular dentures was evaluated considering the following seven factors. These were patient's satisfaction, retention, stability, balanced occlusion, tongue space, anterior teeth arrangement and position of posterior teeth.

Numbers of post insertion adjustment visits were used as an expression of patient's satisfaction.[23-26] Grade I was designated to easily satisfied patients in 1-2 visits. Grade II was allocated to patients satisfied in 3-4 visits. Patients remaining dissatisfied after 5 visits were allocated Grade III.

Retentive qualities of a complete lower denture were gauged by assessing the resistance to vertical displacement. This was evaluated by asking the patient to relax with his/her tongue at rest. A probe was placed between the lower incisor teeth. The resistance to upward pressure of the probe and denture was assessed[20].

Dentures that did not dislodge on upwards pull were assigned Grade I. Grade II was allocated to dentures dislodging with difficulty. Easily dislodged dentures were granted grade III.

Extent of rotation or tilt under finger pressure at premolar or molar areas was noted as an assessment of stability[21]. Grade I was designated to dentures exhibiting no rotation or tilt and no dislodgement. Dentures showing rotation of more than 2 mm but coming back under pressure were grouped as Grade II. Grade III was designated to easily displaced dentures.

A semi-adjustable articulator was used to detect any deflective occlusal contact. Maxillary and mandibular dentures were articulated in centric occlusion. Protrusive record was made by using bite

registration wax. (Aluwax Dental Products Company P.O. Box 87, Allendale, MI 49401). Articulating ribbon was used to mark the interceptive contacts in excursive movements[22].

Dentures with no interference were designated Grade I. Grade II was designated to dentures with interfering contacts in only lateral excursions. Grade III was allocated to dentures with interfering contacts in protrusive as well as lateral excursions.

Relationship of tongue with posterior mandibular artificial teeth was observed[23]. Grade I was allocated to subjects in which the lateral tongue borders were at the level of lingual cusps of lower dentures. Dorsum of tongue was round, smooth and relaxed.

Grade II was designated to subjects where lateral tongue borders were curled up. Tongues showed teeth indentations and contracted dorsum (Cramped tongue). Subjects with lateral borders of tongue lying over posterior teeth were grouped as grade III.

The appearance of vermilion border of lower lip and mentolabial sulcus were observed[24]. Grade I was assigned to patients with normal vermilion border of lower lip and normal contour of mento-labial sulcus. Grade II was allocated to subjects with obliterated or deepened mentolabial sulcus. Grade III was designated to subjects with teeth set too far labially or lingually causing denture dislodgement.

Buccolingual relationship of lower posterior teeth to ridge crest was observed[23]. Grade I was designated to subjects central fossae of posterior teeth coinciding with center of alveolar ridge crest (retro molar pad) on both right and left sides.

Grade II was assigned to subjects with only one side of central fossae of posterior teeth were coinciding with ridge crest. Subjects with no central fossae coinciding with ridge crest were graded as III.

Data Analysis

The data was entered into **SPSS** program version 10.0 and analyzed accordingly. Numerical variables like age and edentulous period were analyzed by calculating mean and standard deviation. ***t* test** was applied to compare the positions of neutral zone and alveolar ridge between groups A and B. Sex and assessment of success of mandibular dentures were qualitative variables. These variables were analyzed by frequency and percentage. Chi-square test (χ^2) was applied to improve the qualitative comparison of the final assessment between all groups. In both tests, ***p*** value of ≤0.05 was considered significant.

RESULTS

A total of 128 edentulous patients were selected according to the specified criteria. They were divided in four subgroups of 32 each (Table 1).

Table 1: *Distribution of study groups (n = 128).*

Group	Description	(n)
A_1	Dentures constructed according to neural zone concept	32
A_2	Dentures based on bone support concept	32
B_1	Dentures constructed according to neural zone concept	32
B_1	Dentures based on bone support concept	32
Total		128

KEY:

A_1 and A_2: Edentulous period of 6 months to 2 years

B_1 and B_2: Edentulous period of more than 2 years

Group A_1 had a mean age of 55.8 years. Group A_2 had a mean age of 56.2 years. Group B_1 had a mean age of 58.3 years while the mean age of Group B_2 was 57.2 years. 89 males and 39 females were included in a total of 128 patients.

Mean length of edentulous period was 1.1 years for group A_1 and 1 year for Group A_2. Mean edentulous period was 4.3 years for group B_1 and 4.2 years for group B_2. To minimize the disparity of length of edentulous periods between the two groups A and B, this confounding variable was controlled (Table 2).

In group A1 37.5% had never used the dentures before. In group A2 59.4% were not experienced denture wearers. In group B_1 78.1% patients were experienced denture wearers. In group B_2 59.4% were experienced denture wearers (Table 3).

Assessment of mandibular dentures was carried out in all groups. Assessments of all groups were statistically compared. Comparison was made among following pairs.

Group A_1 and A_2 (Table 4).

Group B_1 and B_2 (Table 5).

Chi square and Fisher's Exact test was applied to evaluate the p value.

1. **Patient's satisfaction**

Groups A_1 had 17 patients in grade I and 15 patients in grade II. Group A_2 had 16 patients in grade I and 16 patients in grade II. p value for both groups was 0.80 which is statistically non-significant.

Groups B_1 had 25 patients in grade I and 7 patients in grade II. Group B_2 had 13 patients in grade I and 19 patients in grade II p value for both groups was 0.002, which is statistically significant.

2. **Retention**

Groups A_1 and A_2 had 16 patients in grade I and 16 patients in grade II. p values for both groups was 1.0. The p value was statistically non significant.

Group B_1 had 24 patients in grade I and 8 patients in grade II. Group B_2 had 14 patients in grade I and 18 patients in grade II. p value for both groups was 0.01. The p value was statistically significant.

3. **Stability**

Group A_1 had 28 patients in grade I and 4 patients in grade II. Group A_2 had 12 patients in grade I and 20 patients in grade II. The p value for both groups was less than 0.001, which is statistically significant.

Group B_1 had 30 patients in grade I and 2 patients in grade II. Group B_2 had 10 patients in grade 1 and 22 patients in grade II. The p value for both groups was less than 0.001, which is statistically significant.

4. **Occlusion**

Group A_1 had 30 patients in grade I and 2 patients in grade II. Group A_2 had all 32 patients in grade I. p value for both groups was 0.49, which is statistically non-significant.

Group B_1 had 31 patients in grade I and 1 patient in grade II. Group B_2 had all 32 patients in grade I. On comparison, p-values for B_1 and B_2 was 1.00. The p value showed statistically non-significant result.

5. **Tongue space**

Group A_1 had 31 patients in grade I and 1 patient in grade II. Group A_2 had 12 patients in grade I and 20 patients in grade II. On comparison p values for A_1 & A_2 was less than 0.001. The p value is statistically significant.

Table 2: *Length of period of edentulism (Years) (n= 128).*

Serial No.	Date of last extraction in years			
	A_1	**A_2**	**B_1**	**B_2**
1.	1.08	0.83	3.00	4.00
2.	1.50	0.92	4.00	5.00
3.	1.50	0.50	4.50	4.00
4.	1.08	1.25	5.00	3.00
5.	1.00	1.67	3.50	3.50
6.	1.00	1.25	7.00	5.00
7.	0.50	1.25	4.00	5.00
8.	1.00	0.50	1.50	3.00
9.	0.75	0.92	2.00	3.50
10.	1.00	1.08	3.25	4.50
11.	1.17	1.00	3.50	5.00
12.	1.67	1.50	3.42	5.42
13.	1.00	0.92	4.25	4.50
14.	2.00	0.67	3.00	3.00
15.	1.17	0.67	5.00	5.00
16.	0.83	0.50	5.50	6.00
17.	1.50	1.00	5.00	4.00
18.	0.50	0.50	5.50	3.00
19.	0.92	0.50	5.50	5.00
20.	1.25	1.25	4.25	4.50
21.	1.00	1.25	3.42	3.33
22.	1.00	1.50	6.00	6.00
23.	1.67	1.67	2.50	3.00
24.	1.00	1.08	5.00	2.50
25.	1.50	1.50	7.00	2.50
26.	1.00	0.50	3.50	6.00
27.	1.08	1.50	4.00	3.00
28.	1.00	1.00	5.50	3.50
29.	1.25	1.25	6.00	5.00
30.	1.50	1.50	2.50	4.50
31.	1.08	1.50	7.00	5.00
32.	1.50	1.50	4.00	6.00
Mean ± SD	**1.16 ± 0.33**	**1.08 ± 0.39**	**4.35 ± 1.43**	**4.26 ±1.09**

KEY: S.D.=Standard deviation
A_1= Dentures constructed according to neural zone concept, **A_2=** Dentures based on bone support concept, **B_1=** Dentures constructed according to neural zone concept, **B_2=** Dentures based on bone support concept

Group B_1 had 29 patients in grade I and 3 patients in grade II. group B_2 had 11 patients in grade I and 21 patients in grade II. p value for both groups was less than 0.001. The p value is statistically significant.

6. **Anterior teeth arrangement**

Group A_1 had 31 patients in grade I and 1 patient in grade II. Group B_2 had all 32 patients in grade I. p value for both groups were 1.00, which is statistically non significant.

Group B_1 had 30 patients in grade I and 2 patients in grade II. group B_2 had 31 patients in grade I and 1 patient in grade II. p value for both groups was 1.00, which is statistically non significant.

7. **Posterior teeth arrangement**

Group A_1 had 21 patients in grade I and 11 patients in grade II. All patients of Group A_2 were in grade I. p value for groups A_1 and A_2 was less than 0.001, which is statistically significant.

Group B_1 had 10 patients in grade I and 22 patients in grade II. Group B_2 had 18 patients in grade I and 14 patients in grade II. p value for B_1 and B_2 was 0.08.The p value is statistically non significant.

DISCUSSION

In the present study, 128 edentulous patients were selected.

The objectives of the study were to compare the influence of the conventional bone support tooth arrangement scheme and neutral zone tooth arrangement scheme on denture success.

Table 3: *Experienced denture wearer's distribution (n = 128).*

Use of Denture	Study Groups				Total
	A_1	A_2	B_1	B_2	
Used denture	12 (37.5%)	13 (40.0%)	25 (78.1%)	19 (59.4%)	69 (53.9%)
Never used denture	20 (62.5%)	19 (59.4%)	7 (21.9%)	13 (40.6%)	59 (46.1%)
Total	32	32	32	32	128 (100.0%)

KEY:
A_1: Dentures constructed according to neural zone concept
A_2: Dentures based on bone support concept
B_1: Dentures constructed according to neural zone concept
B_2: Dentures based on bone support concept

Table 4: *Assessment of the success of mandibular dentures (Group A_1 and A_2).*

		STUDY GROUPS				P
		Group A_1 (N = 64)		Group A_2 (N =64)		
		frequency	%	frequency	%	
Patient Satisfaction						
	Grade I	17	53.1%	16	50.0%	0.80*
	Grade II	15	46.9%	16	50.0%	
Retention						
	Grade I	16	50.0%	16	50.0%	1.0*
	Grade II	16	50.0%	16	50.0%	
Stability						
	Grade I	28	87.5%	12	37.5%	< 0.001*
	Grade II	4	12.5%	20	32.5%	
Occlusion						
	Grade I	30	93.8%	32	100.0%	0.49**
	Grade II	2	6.3%	0	0.0%	
Tongue space						
	Grade I	31	96.9%	12	37.5%	< 0.001*
	Grade II	1	3.1%	20	32.5%	
Anterior teeth arrangement						
	Grade I	31	96.9%	32	100.0%	1.00**
	Grade II	1	3.1%	0	0.0%	
Position of the Posterior teeth						
	Grade I	21	65.6%	32	100.0%	< 0.001*
	Grade II	11	34.4%	0	0.0%	

Key:* = Chi Square test
** = Fisher's Exact test, p = probability value

Comparison of the clinical success of mandibular dentures constructed with neutral zone and conventional techniques was carried out. They were assessed on seven factors by predetermined criteria. In the present study, 42 neutral zone dentures (A_1 + B_1) and 29 conventional dentures (A_2 + B_2) were allocated grade I for patient's satisfaction. More patients with neutral zone dentures were satisfied than patients with conventional dentures. Barrenas and Odman[25] advocated that myodynamic dentures offer better comfort and function to patients than conventional dentures. They experienced minimum post insertion problems with the myodynamic dentures. Fahmy[1] concluded that comfort and speech performance were better with the neutral zone dentures. However the conventional dentures showed better mastication results. Present study agrees with the study by Barrenas and Odman[29] and Fahmy[1]. In the present study, the satisfaction criterion was based upon the number of post insertion visits. The polished surfaces of the neutral zone dentures were constructed in harmony with patients' oral and facial musculature. This may have helped patients to easily perform oral functions and have minimum post insertion complaints.

Table 5: *Assessment of the success of mandibular dentures (Group B_1 and B_2).*

		STUDY GROUPS				P
		Group B_1 (N = 64)		Group B_2 (N = 64)		
		Frequency	%	Frequency	%	
Patient Satisfaction						
	Grade I	25	78.1%	13	40.6%	0.002*
	Grade II	7	21.9%	19	59.4%	
Retention						
	Grade I	24	75.0%	14	43.8%	0.01*
	Grade II	8	25.0%	18	50.3%	
Stability						
	Grade I	30	93.8%	10	31.3%	< 0.001*
	Grade II	2	6.3%	32	68.7%	
Occlusion						
	Grade I	31	90.6%	32	100.0%	1.00**
	Grade II	1	9.4%	0	0.0%	
Tongue space						
	Grade I	29	90.6%	11	34.4%	< 0.001*
	Grade II	3	9.4%	21	65.6%	
Anterior teeth arrangement						
	Grade I	30	93.8%	31	96.9%	1.00**
	Grade II	2	6.2%	1	3.1%	
Position of the posterior teeth						
	Grade I	10	31.3%	18	51.3%	0.08**
	Grade II	22	68.8%	14	43.8%	

Key:* = Chi Square test
** = Fisher's Exact test, p = probability value

In the present study, equal number of conventional as well as neutral zone dentures were allocated Grade I for retention in patients with shorter period of edentulism. However, increased number of neutral zone dentures were retentive in patients with longer period of edentulism. It is advocated by various researchers that utilization of neutral zone technique may aid in retention of a prostheses.[23,26-29] Present study reveals that arrangement of teeth within neutral zone may play an important role in improving retention of prosthesis. This may be especially true for patients with prolonged edentulous periods.

All mandibular dentures were evaluated for stability. Neutral zone dentures were more stable than conventional dentures. 58 neutral zone dentures (A_1 + B_1) and 22 conventional dentures were allocated grade 1 for denture stability. The difference was especially marked in patients edentulous for more than 2 years. Longer period of edentulism may shift the location of neutral zone with respect to alveolar ridge[7]. Neutral zone dentures were conformed to the

established muscle control. Polished surfaces of the dentures were fashioned to fit the muscle contour. Fibres of the buccinator muscle run parallel along the buccal flange in buccal shelf area. During function, the direction of fibres may aid in seating of the well-contoured denture. This ensured greater stability during function. Beresin and Schisser[30] and Ogle[31] suggested that teeth must be positioned within neutral zone for optimum stability and retention of the prosthesis. Palazzo[32] considered the teeth arrangement within neutral zone as a fundamental factor for obtaining stability in complete dentures. Zaigham[23] concluded that dentures made with selective pressure impression technique for intaglio surfaces and neutral zone technique for polished surfaces might have better retention and stability outcome than conventional dentures. Basker and Davenport[33] supported the neutral zone principle for improved stability. Muscular forces may be considered during denture designing for improved stability[34].

Balanced occlusion was evaluated in all subjects. Results showed similar response from neutral zone and conventional techniques. Balanced occlusion was obtainable in all groups.

All dentures were clinically examined for tongue space. In the present study, 60 neutral zone dentures (A_1 +B_1) and 23 conventional dentures (A_2 + B_2) were allocated grade 1 for tongue space. Neutral zone dentures provided improved tongue space than the conventional dentures in both edentulous periods. Functional molding of cameo surfaces of dentures may be the reason for this response. Teeth were confined within the recorded neutral zone. Tongue was not restricted or forced in to an abnormal position. It allowed better tongue function and improved denture stability. Zaigham[23] also demonstrated that neutral zone dentures provided adequate space for tongue.

Position of anterior teeth was observed in all groups. Results showed adequate contours of mento-labial grooves in all subjects. In the present study, phonetics and esthetics were taken into consideration during arrangement of lower anterior teeth. This allowed lower anterior teeth to be placed in their optimum position in all groups with respect to the soft tissue profile of the patients. Damriel[35] suggested that lower anterior tooth placement must not exceed the middle of the mandibular labial vestibule. He observed that labio-lingual thickness of lower anterior neutral zone was wider than the labio-lingual thickness of lower anterior teeth. Within this dimension, esthetic, phonetics and functional requirements were also considered during teeth arrangement. Beresin and Schisser[30] suggested that lower anterior tooth placement within neutral zone is affected by aesthetic, phonetic and functional requirements. They advocated that wider thickness of lower anterior neutral zone allowed some leeway for labio-lingual tooth positioning. Sufficient vertical and horizontal overlap might be provided for maintaining occlusal balance in eccentric mandibular movements. Zaigham[23] concluded that neutral zone dentures provided better labial flange contours and anterior tooth positions. In his study lower anterior teeth arrangement for conventional dentures was done according to esthetic and functional guidelines. For neutral zone dentures, lower anterior teeth were arranged within boundaries of plaster matrices.

Posterior tooth position was evaluated in all dentures. Results showed that all conventional dentures coincided with the crest of residual ridge bilaterally, in short period of edentulism. On the other hand, 21 neutral zone dentures coincided with the crest of ridge bilaterally in short period of edentulism. During construction of conventional dentures for patients with shorter period of edentulism, teeth were arranged directly on the ridge. This aided in coinciding the central fossae of mandibular posterior teeth with the ridge crest bilaterally. The mean edentulous period for groups A_1 was 1.1 years. Mandibular lingual bone resorption might not have occurred excessively during this duration. Reduced bone resorption might have allowed the teeth to be placed within neutral zone, as well as closer to the ridge crest in most subjects. The study by Carlsson and Persson[36] showed that the mean RRR was 2.75 mm in the first two years. In the present study, edentulous span of 1.1 years might be shorter to exhibit clinically significant change in relation of neutral zone to alveolar ridge crest.

Mean length of edentulous period for groups B_1 and B_2 was 4.3 and 4.2 years respectively. In longer period of edentulism, 18 conventional dentures coincided bilaterally while 14 coincided unilaterally. This may also affect the stability of dentures. Only 10 neutral zone dentures coincided bilaterally, while remaining 22 coincided unilaterally. Fenton[4] suggested that tongue frequently responds to the loss of posterior teeth and supporting bone. It changes its size. Its borders may come in contact with the buccal mucosa. This may alter the potential denture space or neutral zone. However constant presence of a denture may reduce such stimuli. Morphological changes in surrounding musculature may be responsible for such positioning of posterior teeth in the present study. Fenton[4] stated that the posterior teeth might be positioned with respect to the surrounding musculature and the underlying supporting structures. Neutral zone can be the determining factor in the final posterior set up. Damriel[13] stated that generally dynamic registration of neutral zone

might be the optimum choice for tooth arrangement.

Beresin and Schisser[30] advocated the neutral zone principle. They stated that posterior teeth position might be dictated by the musculature. Zaigham[23] concluded that the neutral zone concept may play a significant role in denture success. This may be especially helpful in cases with greater amount of ridge reduction.

Present study revealed that both the neutral zone and conventional techniques play equally important role in the success of mandibular dentures. The decision to utilize any one technique depends upon the clinical conditions. The clinical conditions may be affected by the period of edentulism. Edentulous period may affect the amount of bone resorption and tonus of the surrounding musculature. In the present study, neutral zone dentures were more stable in prolonged edentulous period. These results coincide with the previous studies.[3,7,15,23]

It is **concluded** that:

- With shorter edentulous periods, teeth may be placed over the ridge or with in neutral zone. The tone and contour of the surrounding musculature may be considered in tooth arrangement. The well-formed residual ridge may adequately support and retain the dentures.
- Neutral zone may be recorded for patients with longer edentulous periods. Multi-factorial residual ridge resorption may alter the relation of teeth to alveolar ridge. The neutral zone record may aid in determining the correct tooth position.

Statistical analysis of the assessment of dentures' outcome showed that in prolonged edentulous periods, arrangement of teeth within neutral zone may improve the retention and stability of prosthesis. The length of edentulous period, extent of bone resorption and contour of the musculature surrounding the edentulous space may affect the arrangement of teeth and the success of prosthesis.

For future research, a comprehensive patient's response questionnaire may be designed to assess the patient's response to denture service. Comparison of neutral zone record made by different materials (silicone, tissue conditioner, denture lining materials, soft wax, and polymer of dimethyl siloxane with calcium silicate) may also help in correct judgement of the potential denture space. This can eliminate the effect of properties of one specific material on neutral zone record.

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