Research Article

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Evaluation of Position of Neutral Zone in Relation to that of Conventionally Fabricated Mandibular Occlusal Rim Based on Available Bone-Support for Different Periods of Edentulousness: A Clinical Study

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ABSTRACT

Background: The purpose of this study was to evaluate the position of neutral zone in relation to that of conventionally fabricated mandibular occlusal rim based on bone support for different periods of edentulousness.

Materials and methods: The position of neutral zone was evaluated in comparison to that of conventional occlusal rim fabricated on the basis of bone support for 20 patients. The patients were divided into 2 groups based on their periods of edentulousness. Group I comprised patients with edentulous period of 1-5 years and Group II with edentulous periods of 6-10 years. For each case neutral zone recording was done and its position was compared to that of occlusal rim made based on the bone support using a graph paper. The data collected was subjected to unpaired t-test and post hoc Bonferroni test for statistical analysis.

Results: The results suggested that the neutral zone varies from individual to individual based on their musculature and period of edentulousness.

Conclusion: This study made it obvious that the occlusal rim made on the basis of bone support, even when meticulously done, can violate the neutral zone.

Keywords: Fabricated Mandibular Occlusal Rim, Neutral Zone, Bone support.

INTRODUCTION

According to one estimate by 2045, the number of elderly in the world is likely to surpass the number of children for the first time in history.[1] With increase in life expectancy we, the dental professionals, are bound to see an increasing number of elderly cases with partial and complete edentulism. Elderly patients, especially the long-time denture wearers, have advanced ridge atrophy and atrophy of the musculatures of the lips and cheeks.[2] With improved quality of life, a large section of the population experience tooth loss at a later stage in life; this makes it difficult for them to develop the neuromuscular skills needed for successful wearing of dentures. The lack of the neuromuscular skills makes wearing dentures on atrophic ridges an uphill task.[3]

Because of the progressive changes that accompany edentulism,[4,5] the functional dynamics that defines the oral cavity,[6] and the loss of the patient's capability to adapt with increase in age, rehabilitation of edentulous cases becomes more challenging.[7] After dental extractions the alveolar bone may resorb until only basal bone remains.[4]

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Furthermore, systemic diseases such as diabetes mellitus, osteoporosis, osteosclerosis, and osteomalacia can exacerbate the situation. [7] Resorption of the residual ridges is a continued process and can produce a flat and sometimes even a concave foundation. [8] These ultra resorbed ridges have been called the difficult lower jaw in literature. Many times systemic conditions and financial constraints can also prohibit an otherwise possible surgical and implant-based treatment of such cases.

In edentulous cases the lips and cheeks tend to collapse into the oral cavity, and simultaneously the tongue to fan out. Under such situation the success of complete dentures depends on the careful considerations of certain anatomic and physiologic facts.[9,10] Improper tooth arrangement or physiologically unacceptable denture base volume or contour result in poor prosthesis stability, compromised phonetics, inadequate facial tissue support, inefficient tongue posture and function. To manage such difficult situation for the mandibular denture, Fish in 1933, drew the attention of the profession towards the cameo or polished surface of the prostheses.[11]

The loss of all natural teeth results in a potential denture space in the oral cavity. Within this potential denture space there exists a zone where the forces of the tongue pressing outward are neutralised by the forces of the lips and cheeks pressing inward. This is known as the neutral zone. According to the Glossary of Prosthodontic Terms (2005), the neutral zone is " the potential space within the lips and the cheeks on one side and tongue on the other; that area or position where the forces between the tongue and cheeks or lips are equal."[12]

In the literature, the neutral zone has been called the dead space[13], stable zone[8], zone of least interference[14], zone of equilibrium[15], biometric denture space[16], and potential denture space [17]. The technique for recording the neutral zone has been referred to as the anthropoidal pouch technique[18], muscle formed mandibular denture technique[19], and piezograph technique [20].

The term neutral zone technique was coined by Beresin and Schiesser in 1976.[21] They suggested that the denture teeth should be arranged in the neutral zone as this achieves 2 objectives: teeth do not interfere in the normal muscle function; and the forces exerted by the musculature against the denture are more favourable for stability and retention. [21,22,23]

In view of the importance of neutral zone in complete denture construction, it was thought feasible to determine relation between the centres of the alveolar ridge crest in relation to the neutral zone in a buccolingual direction which would help in positioning of the teeth in a region of minimum conflict so that the stability of the denture is enhanced. [24]

MATERIALS AND METHODS

With the neutral-zone approach, the usual sequence for complete denture fabrication is reversed. First the individual trays are fabricated and adjusted after trial base insertion in the mouth. This is followed by making occlusal rims with modeling plastic impression compound, which, in turn, is molded in the neutral zone by muscle functions. Later, a definitive impression is made by using a closed mouth procedure at a tentative occlusal vertical dimension. After this procedure, the occlusal vertical dimension and centric relation are determined. The shape of the polished cameo surface determines whether the muscular forces will stabilize or dislodge the denture. Additionally, this helps patients to control their dentures even when the residual ridges have atrophied and the fit is no longer accurate.[23]The proper position of the teeth is not in the center of the ridge, nor labial or buccal to it, but where the cheek pressure and tongue pressure balance each other.[24]

In our study, however the cinical procedures were carried out till final impression in conventional manner, then permanent denture bases were made with self-cure acrylic resin just to insure a proper fit using the sprinkle-on technique. For each case, maxillary occlusion rim was made with modelling wax. Two mandibular denture bases were made for each case. One occlusion rim was made with modelling wax while the other was made with low fusing compound (green stick).

The maxillary occlusion rims were adjusted in conventional manner to proper height and labiolingual inclination for each case. For each case the mandibular occlusion rim which was made with

modelling wax based on bone support obvious from the cast was conventionally adjusted till a flat contact with the opposite mandibular rim (Photo 1). On the second record base three vertical stops of self cure acrylic resin were placed, one anterior and one posterior on either side. The height of the stops were deliberately kept higher than that of the adjusted occlusion rim made in wax.

Recording of the neutral zone: The neutral zone (Photo 2) was recorded using low-fusing impression compound (DPI, PINNACLE, Mumbai, India). The impression compound was softened using warm water and carefully placed in the mouth and the patient was asked to perform different oral functional movements like swallowing, sucking repeatedly.

Measurements: The wax occlusion rim and the recorded neutral zones were flattened to almost similar heights. Their occlusal imprints were transferred on graph papers and measurements were taken for comparable parts.

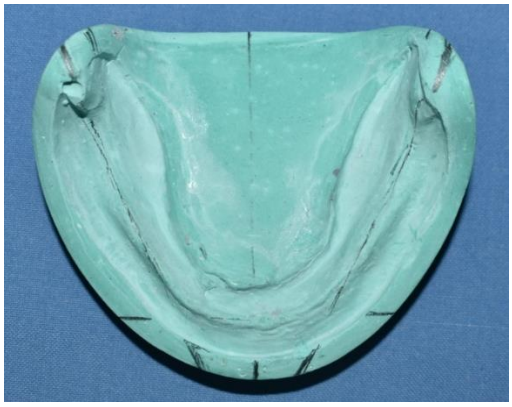

Fig 1: Mandibular cast

Fig 2: Mandibular occlusal rim made based on bone support (landmarks)

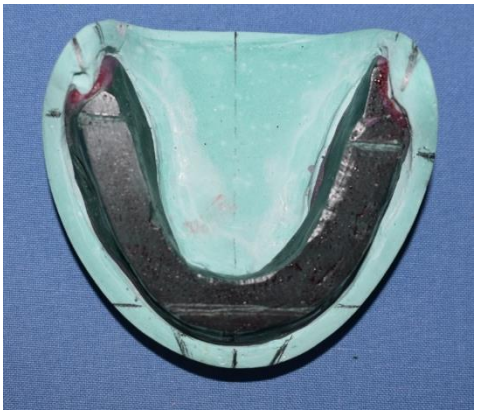

Fig 3: Mandibular neutral zone recorded functional.

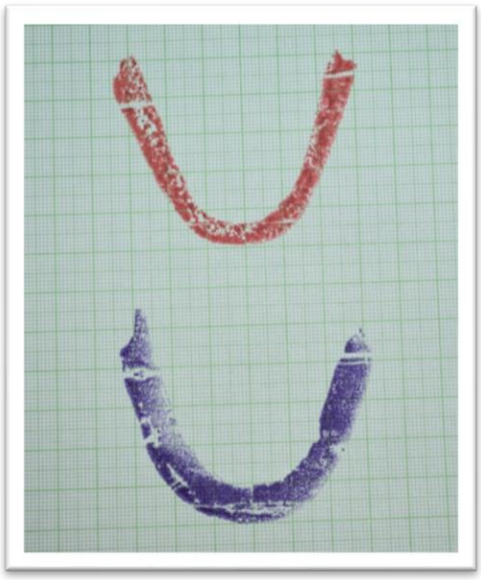

Fig 4: Imprints of the occlusal surfaces of the conventional occlusal rim and the recorded neutral zone used for measurements.

RESULTS

The basic data collected from 20 patients to correlate the position of the neutral zone in relation to the crest of the ridge is presented in Tables 1 and 2. The patients were classified according to their period of edentulousness into two groups. The first group was edentulous for 1-5 years,and the second group for 6-10 years . Table 1: Shows position of neutral zone to the centre of the conventionally fabricated occlusion rims in 5 different locations for patients edentulous between 1 to 5 years (group I). In this group, in 23 locations the neutral zone was

located lingual to the crest of the ridge, in 23 locations the neutral zone was located buccally or labially and in 4 locations the neutral zone coincided with the crest of the alveolar ridge. Table 2: Shows position of the neutral zone to the crest of the alveolar ridge for patients edentulous between 6-10 years (group II). In this group, in 28 locations the neutral zone was located lingual to the crest of the ridge, in 21 locations the neutral zone was located buccally or labially, and in 1 location the neutral zone coincided with the crest of the alveolar ridge.

Table 1: Shows position of neutral zone relative to that of the conventional occlusal rims for patients edentulous between 1-5 years.

Number of Cases	Period of edentulousness	Left molar region	Left premolar region	Anterior region	Right premolar region	Right molar region
1	1	-1	1	1	1	-1
2	1	0	-1	0	1	-1
3	1	-1	1	-1	1	-2
4	2	-1	1	0	1	2
5	3	1	-1	1	-1	3
6	3	2	1	0	1	2
7	4	2	-1	-1	1	-3
8	5	-2	1	-1	1	-2
9	5	-2	-1	1	1	-3
10	5	-3	1	-1	-1	-2

Table 2: Shows position of neutral zone relative to that of the conventional occlusal rims for patients edentulous between 6-10 years.

Number of Cases	Period of edentulousness	Left molar region	Left premolar region	Anterior region	Right premolar region	Right molar region
1	6	-2	-1	1	1	-3
2	6	-3	2	1	1	2
3	6	-2	1	-2	2	-2
4	7	2	2	-3	1	2
5	7	3	0	-2	1	-2
6	9	-2	2	-2	-1	-3

7	9	-3	1	-3	2	-2
8	10	-3	2	-2	-1	-2
9	10	-3	2	-2	2	-3
10	10	-4	2	-3	-2	-2

Table 3: Unpaired t-test

	Group I (edentulous for the last 1-5 years)		Group II (edentulous for the last 6-10 years)				
	Mean	Std. Deviation	Mean	Std. Deviation	Mean Difference	t-test value	p-value
Left molar region	-0.50	1.716	-1.70	2.312	1.200	1.318	0.204
Left premolar region	0.20	1.033	1.30	1.059	-1.100	-2.351	0.030
Anterior region	-0.10	0.876	-1.70	1.494	1.600	2.921	0.009*
Right premolar region	0.60	0.843	0.60	1.430	0.000	0.000	1.000
Right molar region	-0.70	2.214	-1.50	1.900	0.800	0.867	0.397

Table 4: Post-hoc Bonferroni test for group I (1-5 years)

		Mean Difference	p-value
Left molar region	Left premolar region	-0.70	1.000
Left molar region	Anterior region	-0.40	1.000
Left molar region	Right premolar region	-1.10	0.842
Left molar region	Right molar region	0.20	1.000
Left premolar region	Anterior region	0.30	1.000
Left premolar region	Right premolar region	-0.40	1.000
Left premolar region	Right molar region	0.90	1.000
Anterior region	Right premolar region	-0.70	1.000
Anterior region	Right molar region	0.60	1.000
Right premolar region	Right molar region	1.30	1.000

Table 5: Post-hoc Bonferroni test for group I (6-10years)

		Mean Difference	**p-value**
Left molar region	Left premolar region	-3.00	0.045*
Left molar region	Anterior region	0.00	1.000
Left molar region	Right premolar region	-2.30	0.044*
Left molar region	Right molar region	-0.20	1.000
Left premolar region	Anterior region	3.00	0.017*
Left premolar region	Right premolar region	0.70	1.000
Left premolar region	Right molar region	2.80	0.009*

Anterior region	Right premolar region	-2.30	0.039*
Anterior region	Right molar region	-0.20	1.000
Right premolar region	Right molar region	2.10	0.156

DISCUSSION

Our prime objectives while fabricating complete dentures for an edentulous patient is to establish support, retention, stability, esthetics and phonetic and chewing comfort. The concept of neutral zone plays an important role in attaining most of these complete denture objectives with very little extra effort.[25,26,27] The present study attempts to relate the position of the neutral zone relative to that of conventionally fabricated occlusion rims basaed on bone support in a buccolingual direction and its relation to the period of edentulousness. Literature is abundant which advocates the need for positioning the teeth in the neutral zone. Based on its usefulness in complete denture prosthetics, this study was conducted to ascertain the position of the neutral zone in relation to what we usually think it should be as evident from the available bone support. The method used in this study would be beneficial in these instances to locate the ridge-neutral zone relation. Low-fusing impression compound was used for this study. The material is easily mouldable by the forces of tongue and circumoral muscles and has got sufficient working time and therefore can be used to accurately locate the neutral zone. The imprints of the occlusal surfaces of both the conventionally fabricated occlusion rims and those of neutral zone recordings were taken on graph papers with the help of stamp pads and readings were taken. The result obtained from this study on patients with edentulous period upto 5 years showed the neutral zone to be located lingually by a mean of 0.1 to 1.6mm in the anterior region (Table 3). It indicates the need to place the mandibular teeth a bit lingual to where we usually place them. This finding was not in agreement with the study conducted by Lammie G.A in 1956. [28] with increase in age, this appeared to shift lingually . This means that the neutral zone was located more labial to the crest of the ridge, but not to the extent we think it should be. However, phonetics and aesthetics should be considered while setting anterior teeth. Fahmi F.M also arrived at a similar conclusion from his study in 1991.[24] This is because anterior mandibular residual ridge indeed resorbs lingually as time lapses, but we often tend to overcompensate that.

The neutral zone in premolar region in patients who were edentulous for 1-5 and 5-10 years was found to be located buccally by a mean ranging from 0.2 to 1.3 (Table 3). In this region, the neutral zone was located slightly buccal to the crest of the ridge. So the position of the neutral zone does not vary considerably in the premolar region, which is in agreement with the study conducted by Weinberg in 1958. This study found no significant difference in the position of neutral zone when compared to that conventional occlusal rims. In both group I and group II, the neutral zone was located more lingual to that of occlusion rims made conventionally. So the molar teeth should be positioned more lingually to the ridge crest for the cases belonging to this group. The neutral zone in the molar region was found to be lingually located by a mean ranging from -0.5 to -1.70 mm in patients . This means that the neutral zone was located even more lingual to the crest of the ridge. Accordingly the molar teeth should be positioned more lingually to the crest of the ridge for patients in group II compared to the group I. As the period of edentulousness increases, the mandibular ridge resorbs from the lingual side in the molar region. By this pattern of resorption the arch will become wider in the posterior region. So the position of the neutral zone is lingual to crest of the alveolar ridge.[29] So mandibular posterior teeth should be placed towards the lingual side and the discrepancy in this position increases as time lapses, this is in accordance to Martone's (1963) conclusions.[30] Findings in Table 4 and Table 5 made it obvious that difference in position of neutral zone and that of conventional occlusion rims in molar zone was not significant. Wright C.R. (1966) showed that if the sizes of the mandibular teeth are too large (buccolingually) or if the posterior teeth are set even 1 mm lingually, the tongue is deprived of approximately 1000 mm3 of its functional space. This can force the tongue into an abnormally retracted position. In addition, the transformation from the dentulous to edentulous state causes one-tenth increase in tongue size. He indicated that the

mandibular denture would receive more tongue pressure as a result of this increase in size.[23] These factors should be considered while placing posterior teeth in dentures. The results obtained from this study serves as a guideline for the bucco-lingual placement of artificial teeth in complete dentures.

CONCLUSION

The present study was carried out to determine the correlation between the neutral zone recording in relation to the position of occlusion rim made based on available bone support and the period of edentulousness.

1. In patients with history of less than 5 years of edentulousness, the neutral zone was located slightly lingual to the crest of the ridge in the molar region and slightly labial to the crest of the ridge in the anterior region, but still lingual to that shown by the occlusion rim.

2. As the period of edentulousness increases, the position of the neutral zone changes more towards lingual in the molar region and more towards labial in the anterior region, with respect to crest of the residual ridge.

3. The position of the neutral zone remains more or less constant in the premolar region with respect to crest of the residual ridge.

4. The position of the neutral zone in relation to the alveolar ridge was found to be highly affected by the period of edentulousness. Since neutral zone serves as a guide, it is suggested that the period of edentulousness should be considered while arranging the teeth for complete dentures.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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