

A Comparative Study to Check the Effect of Different Occlusal Vertical Dimensions on the Dental Esthetics and Smile

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Abstract

Background: To compare the effect of different occlusal vertical dimensions (OVDs) on the dental esthetics and smile. **Methods:** Fifteen dentate subjects, between the ages of 21–35 years were selected. Inter-labial gap height, inter-commissural width, incisal edge – upper lip, incisal edge – lower lip measurements were made with Polyvinylsiloxane bite registration material at different OVDs of 0 mm, 2 mm, 3 mm, 5 mm and 7 mm thickness. Manual measurements were made in posed smile and the smile index was obtained by dividing width by height. **Results:** The inter-labial gap height, incisal edge to lower lip distance is increased significantly ($P = 0.011$; 0.022) whereas the smile index decreased significantly ($P < 0.001$) with every increase in OVD. No significant changes were observed in the inter-commissural width and incisal edge to upper lip distance. **Conclusion:** The inter-labial gap height, incisal edge to lower lip distance increased and smile index decreased with increased OVD. However, the width of the smile and the length of the upper lip tend to remain unchanged.

Keywords: Occlusal vertical dimension, Dental esthetics, Smile, Smile index.

INTRODUCTION

In dentistry, one of the most challenging tasks is to correct severely attrited teeth with fixed dental prosthesis. Occlusal wear has mostly been attributed to attrition, erosion, abrasion, and parafunctional habits. Excessive wear of anterior dental elements is a fact of high influence on the dental esthetics and harmony of an individual. As cases become more complex, aspects related to the patient's occlusion re-establishment must be observed, including the recovery of the occlusal vertical dimension (OVD).^[1]

Turner and Missirilian classified the patients with occlusal wear as: Category No. 1: Excessive wear with loss of OVD. Category; No. 2: Excessive wear without loss of OVD but with space available. Category No. 3: Excessive wear without loss of OVD but with limited space.^[2,3]

The most common reasons dentists consider altering vertical dimension are: (1) to improve esthetics by altering facial form and/or tooth and gingival display; (2) to improve occlusal relationships, such as correcting anterior open bites; and (3) to gain space for the restoration of short or worn teeth.^[4] Therefore, increase OVD should be determined on the basis of the dental restorative needs and esthetic demands.^[5] In addition, increasing the OVD changes the vertical and horizontal overlap

relationship of the anterior teeth and may alter facial esthetics in a positive way.^[6]

Another consideration for altering OVD is soft tissue profile. As esthetics have become increasingly important in the practice of modern dentistry and are synonymous with a natural, harmonious appearances,^[6] the goal of an esthetic makeover is to develop a peaceful and stable masticatory system, where the teeth, tissues, muscles, skeletal structures, and joints all function in harmony. It is very important that when planning treatment for esthetics cases, smile design cannot be isolated from a comprehensive approach to patient care.^[6,7]

Smile line refers to an imaginary line along the incisal edges of the maxillary anterior teeth which should mimic the curvature of the superior border of the lower lip while smiling. Under ideal conditions, the gingival margin and the lip line should

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be congruent or there can be a 1–2 mm display of the gingival tissue.^[7]

Esthetic of smile depends on relationship between the teeth and lips and the way that lips and soft tissue frame the smile.^[8] There are indications that there are differences in facial movements between the genders. Modern psychological research indicates that men and women possess different smile behavior.^[8–10] Hence, this study is planned to effect of increased OVD on dental esthetics and smile. As in full mouth reconstruction, the OVD is often increased to provide adequate restorative space or for esthetic reasons.

MATERIAL AND METHODS

The study was conducted in the Department of Prosthodontics and Crown and Bridge, Career Postgraduate Institute of Dental Sciences and Hospital, Lucknow. It involves equal number of male and female dentate subjects. All subjects were in between 20 and 35 years of age. Written consent was taken from all the subjects after explaining the procedures in detail. All subjects were equally divided into three groups: Group A: 20–25 years, Group B: 26–30 years, Group C: 31–35 years.

The inclusion criteria of the study were age between 20 and 35 years, No missing anterior teeth and at least 3 teeth in occlusion in both posterior segments. The exclusion criteria were history of surgery in the facial area or any neurologic disorders, lip irregularity, inability, or unwillingness to smile or any gross facial asymmetry.

Methodology

Impression making and Facebow record

Irreversible hydrocolloid impressions were made using metal stock trays. Impression was poured with type III dental stone. After trimming and indexing, the poured cast was articulated on semi adjustable articulator using arbitrary facebow transfer as shown in Figure 1 and lower cast was mounted using centric record made with silicone bite registration material in maximum intercuspation (Figure 1).

Fabrication of bite splints on semi adjustable Articulator

Bite splints was fabricated by raising OVD with the help of calibration on the incisal rod of Hanau Wide view semi adjustable articulator. Sequential OVD opening was done on the articulator by +2 mm, +3 mm, +5 mm, and +7 mm. At these openings, silicone bite registration material was injected onto the occlusal surfaces from 1st premolar to 2nd molar, which was later on used to obtain the desired openings. The bite splints was then trimmed and disinfected, so that they can be placed properly in patient's mouth and were stored in color coded plastic bags. The following color codes were used for the various bite splints; Black – 0 mm, Red – 2 mm, Blue – 3 mm, Green – 5 mm, Yellow – 7 mm (Figure 2).

Measuring dental esthetics and smile parameters with various bite splints

Various bite blocks made of different OVD (0 mm, 2 mm, 3 mm, 5 mm, 7 mm) was placed in patient's mouth and

following measurements were taken during smiling. Points of measurements are shown in the Figure 3.



Figure 1: Facebow record

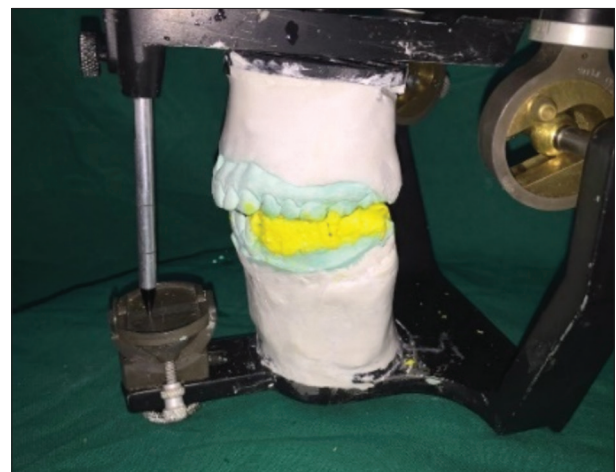


Figure 2: Fabrication of bite splints on articulator

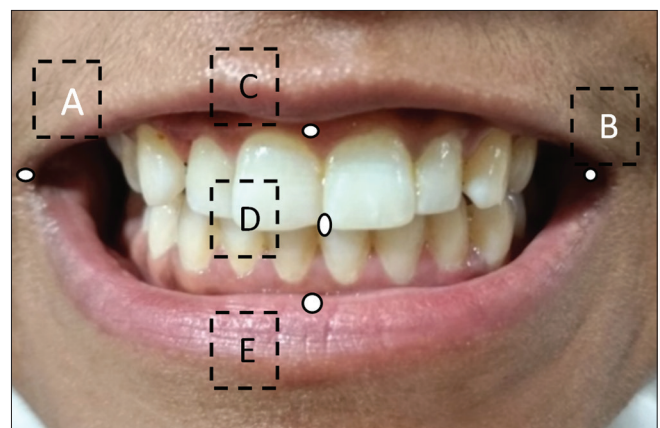


Figure 3: Points of measurements. Inter-labial gap height (c-e), Inter-commissural width (a and b), Incisal edge to upper lip (c and d), Incisal edge to lower lip (d and e)

Inter-labial gap height

The upper midpoint of the incisal embrasure (at cervical level) between 11 and 12 and lower midpoint of incisal embrasure (at cervical level) between 31 and 41 is marked. The distance between the two points was taken and measured with a divider and metallic scale.

Inter-commissural width

Distance between the left and right commissures was measured at a posed smile. After marking the points, one at right commissure and another at left commissure, the distance was measured between two points using flexible scale.

Incisal edge – Upper lip

Two points were marked, one at inferior border of upper lip and second between the lower midpoint (incisal edge level) of the incisal embrasure between 11 and 21 and the distance between two points was measured with divider and metallic scale.

Incisal edge – Lower lip

Two points were marked, one at the lower midpoint (incisal edge level) of the incisal embrasure between 11 and 21 and another at the inferior border of lower lip and the distance between the two were measured with divider and metallic scale.

Smile index

To obtain the smile index, inter-commissural width measurement was divided by inter-labial gap height measurement.

Smile Index = ICW/ILGH

RESULTS

For inter-labial gap height, the mean measurement at OVD + 0 mm was 11.4 ± 4.5 mm. A statistically significant difference ($P < 0.011$) was found with increasing OVDs. Pairwise comparisons using Bonferroni corrected paired *t*-tests revealed all groups to be significantly different from each other ($P < 0.01$) (Table 1).

For inter-commissural width, the mean measurement at OVD +0 mm was 74.67 ± 8.7 mm. No statistically significant difference was found with increasing OVD ($P = 0.767$) (Table 1).

For Incisal edge to upper lip length, the mean measurement at OVD +0 mm was 5.4 ± 1.8 mm. No statistically significant difference was found with increasing OVD ($P = 0.4$) (Table 1).

For incisal edge to lower lip length, the mean measurement at OVD +0 mm was 5.6 ± 3.3 mm. A statistically significant difference was found with increasing OVD ($P < 0.001$). Pairwise comparisons revealed all main measures to be statistically significant with each other ($P < 0.005$).

Individual measurements are presented in Table 1:

DISCUSSION

The esthetic effects of increase in OVD have not been extensively studied. Currently, there have only been reports

Table 1: Standard deviation and p-value for all 5 parameters at different OVD

Measurment	OVD	Mean (SD)	P value
Inter-labial gap height (mm)	0	1.14±0.45	<0.011
	2	1.407±0.30	
	3	1.473±0.32	
	5	1.556±0.36	
	7	1.573±0.35	
Inter-commissural width (mm)	0	7.467±0.87	0.767
	2	7.74±0.65	
	3	7.707±0.60	
	5	7.667±0.39	
	7	7.68±0.41	
Smile index	0	7.78±3.61	<0.001
	2	5.67±1.23	
	3	5.4±1.1	
	5	5.02±1.03	
	7	4.94±0.94	
Incisal edge – upper lip	0	0.54±0.18	0.4
	2	0.64±0.12	
	3	0.61±0.11	
	5	0.6±0.16	
	7	0.56±0.17	
Incisal edge – lower lip	0	0.56±0.33	<0.001
	2	0.86±0.43	
	3	1.11±0.77	
	5	1.38±1.12	
	7	1.74±1.70	

OVD: Occlusal vertical dimension

on the effects of OVD increase to lower facial height and soft tissues at rest. In the present study, a change of +7 mm in OVD yielded a +4.0 mm change in interlabial gap height, and a +4.2 mm change in incisal edge – lower lip distance at smile. These findings were similar to findings by Gross, who found a +4 mm change in lower face height with +8 mm change in OVD. It is likely that this finding is a combination of several factors. First, change in OVD is measured from CEJ to CEJ, which is not perpendicular to the “line of sight” of the photograph taken. This change in angulation may cause a slight discrepancy in the measured vertical distances. The angle between CEJ and CEJ and the line of sight also increases as OVD is increased, yielding less vertical change for each progressive increment of OVD. Second, soft tissue changes are likely to occur to a lesser degree than hard tissues.^[11] Soncul and Bamber evaluated the soft tissue changes after orthognathic surgical correction of Class III deformities and found a 50–70% change in upper and lower vermillion borders in comparison to changes in hard tissue profile.^[12]

Kamashita *et al.* found similar results using wax rims with variable amounts of lip support. With a 5 mm facial addition to the upper and lower wax rims, a gain of 2.9 mm was observed in the upper lip relative to the E-line. Other factors, such as the variability of contractile forces at different muscle lengths may also play a role. The importance of the position of the upper lip at smile has been well documented in the literature.^[13] Tjan

et al. defined the “average smile” as one that reveals 75–100% of the maxillary anterior teeth and interproximal gingiva.^[14] Hulsey found subjects who had an upper lip which was at the height of the gingival margin of the upper central incisor to be the most esthetically pleasing. Currently, the effect of OVD on upper lip position has not been studied. One case report claimed that increasing the vertical dimension increases the crown-to-gum ratio and effectively decreases the gummy smile.^[15]

However, in the present study, no statistically significant change was found with respect to the upper lip at smile with increasing OVD. One possibility may be that individual differences or patient adaptability after an increased OVD accounted for the perceived lowering of the upper lip at smile observed in the case report. Another possibility may be that gingival recession following prosthetic treatment had occurred. In any case, the results of the present study suggest that for treatment planning purposes, the upper lip at smile should not be expected to move down from increased OVD.

The smile index (width-height) at OVD +0 mm was 7.78 ± 3.61 . Similar results were obtained by Desai *et al.*, who found an average smile index of 6.73 ± 2.09 in the 20–29-year-old age group. They also found that the smile index increased with age, progressing from 5.63 in the 15- to 19-year-old age group to 8.05 in the 50-years-old and older age group.^[16] In the present study, an increase in the OVD led to a decrease in the smile index, which progressed from 7.78 at +0 mm OVD to 4.94 at +7 mm OVD. These results indicate that the OVD had a profound effect on the smile index.

One epidemiological study found the prevalence of US children 9–18 years with at least one orthodontic visit to range from 14.3% to 16.8%. In the same study, racial and socioeconomic differences were found, with black children less likely to have made a visit compared to white children, even among children of high socioeconomic status. Another factor for this discrepancy may be that dental students were generally brought up in families that were more attenuated to dental health than the general public. This finding suggests that using dental students as research subjects, although convenient, may not be a good representation of the general public.^[2,5,12,13]

It should be noted that the present study has several major limitations. First, the age range of 21–35 years may not represent the typical prosthodontic patient. Significant discrepancies with respect to age should be anticipated. Second, the bulkiness and removable nature of the silicone bite splints may have negatively influenced the smile. In addition, since all of the data was collected in one sitting, the long-term adaptation of the facial muscles could not be assessed.

Finally, none of the subjects in the present study have lost OVD. It is likely that patients who have had extensive loss of tooth structure or loss of teeth will behave differently as OVD is restored. Further studies are necessary to provide a clear understanding of the long term clinical implications for the effect of OVD change on the smile.

CONCLUSION

Within the limitations of this study, the following conclusions may be drawn:

1. Excessive increase of OVD may lead to excessive interlabial gap height and incisal edge – lower lip length.
2. A lengthening of the upper lip at smile should not be expected with increase of OVD.
3. A change in the width of the smile should not be expected with increase of OVD.

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