**Occlusal Vertical Dimension: Effect on Esthetic Norms at Smile**

Aayesha Razzaque, Shalini Joshi, Sunil Dhaded, Chandra Shekar Sajjan, Priyanka Konin, T. Subashani

Department of Prosthodontics, AME’s Dental College and Hospital, Raichur, Karnataka, India

**Abstract**

**Background and Objectives:** The restorative and esthetic needs for the complete mouth rehabilitation patient frequently require an increase in occlusal vertical dimension (OVD), in whom there would be tooth loss or attrition in existing teeth, decreased OVD, or opposing teeth supraeruption. The effect of increasing OVD for restorative purpose and esthetic norms while smiling is not well understood; hence, the purpose of this study is to evaluate the effect of those norms at smile. **Methods:** Eighty patients (40 males and 40 females) were selected from the student population of AME’s Dental College, Raichur, between the age groups 21 and 30 years, and occlusal registrations of 2, 4, 6, and 8 mm in thickness for each individual were fabricated from the articulated casts. Posed smile images at OVD +0, +2, +4, +6, and +8 were taken with a digital single lens reflex (DSLR) camera and evaluated using AutoCAD software. **Results:** In this study, it was found that with an increase in OVD, the interlabial gap height, incisal edge to lower lip distance, and display zone area were increased statistically significantly ($P < 0.05$) in both male and female patients, whereas the smile index was decreased significantly ($P < 0.05$). No significant changes were observed in the intercommissural width and incisal edge to the upper lip distance in both male and female patients. **Conclusion:** There is obvious effect of aesthetic norms such as the vertical distance between the incisal edge to upper lip, vertical distance between incisal edge–lower lips, interlabialgap height, intercommissural width, internal display zone area, and smile index in both male and female patients. The obtained values can serve as guide for esthetic rehabilitation of patients.

**Keywords:** Dental esthetics, dental photography, display zone, esthetic smile, occlusal vertical dimension, smile line

**INTRODUCTION**

Harmonious relationship between the teeth, gingival scaffold, and the lip framework defines an esthetic smile. The display zone of smile is composed of the size, shape, position, and color of the displayed teeth along with its gingival contour including the buccal corridor and the frame of lips. Harmonious relationship between the teeth, gingival scaffold, and the lip framework defines an esthetic smile. The display zone of smile is composed of the size, shape, position, and color of the displayed teeth along with its gingival contour including the buccal corridor and the frame of lips. One more important factor of esthetic zone is the effect of age on lip line height because as the age progresses, the lips loses its elasticity and becomes less mobile, resulting in more display of mandibular teeth as compared to maxillary teeth during smiling.

Esthetics, patient’s comfort, and function are greatly influenced by the changes in the occlusal vertical dimension (OVD). The restorative needs for the prosthodontic patient frequently require an increase in OVD, which is mainly determined by the remaining teeth. A loss in interarch space may be due to loss of tooth structure and concomitant loss of OVD or supereruption of opposing teeth into edentulous spaces. Increasing the OVD provides greater interocclusal restorative space and may lessen the need for clinical crown lengthening or endodontic procedures in patients who have generalized and complex dental abnormalities. Changes in the soft-tissue profile while altering the OVD is an important consideration, as the vertical dimension of occlusion increases, the distance between the maxilla and the mandible is increased. Hence, the position of the upper and lower lips at smile is most likely to change with increased OVD. Thus, by changing the OVD, it is possible that the distance between the corners of the mouth will also be altered.

The treatment modalities used to achieve an increase in OVD have been questioned by authors who see an alteration of OVD as interfering with the physiology of the masticatory system and the patient’s ability to adapt or who believe it will cause

**Access this article online**

**Quick Response Code:**

Website: www.ijds.in

**DOI:**

10.4103/IJDS.IJDS_57_18

**Address for correspondence:** Dr. Shalini Joshi, Professor, Department of Prosthodontics, AME’s Dental College and Hospital, Raichur, Karnataka, India. E-mail: drshalinibn@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms. For reprints contact: reprints@medknow.com

**How to cite this article:** Razzaque A, Joshi S, Dhaded S, Sajjan C, Konin P, Subashani T. Occlusal vertical dimension: Effect on esthetic norms at smile. Indian J Dent Sci 2018;10:220-5.
transient or permanent hyperactivity of the masticatory muscles, higher occlusal forces, bruxism, and temporomandibular disorders (TMDs). The rehabilitative procedures used to increase the OVD should be used cautiously, with respect for the clinical considerations of this decision.\[3\]

Achieving esthetics after thorough treatment planning has been one of the main interests of the prosthodontists. Many studies have been done on various concepts of treating the patients to obtain harmonized occlusion, function, and esthetics.\[4-6\]

Hence, the paramount objective of modern prosthodontic therapy should not only be the replacement of missing teeth but also to produce maximum stability together with a functional occlusion and improvement of the facial esthetics. A well-balanced smile should always be an important treatment objective. Hence, a clinical study was conducted in Indian population to evaluate the effect of increasing OVD on dimensional measures or esthetic norms of smiles.

**METHODS**

In the present study, 80 patients of both male and female were between the age groups of 21 and 30 years were selected. Written and verbal informed consent were taken from all the participants before the start of the study. The study was envisaged after the approval from the Ethical Committee Board of AME’s Dental College and Hospital and Research Center, Raichur, Karnataka.

The inclusion criteria for the study were that the patients should be between 21 and 30 years of age, should be voluntarily involved in the study, have no missing anterior teeth, the maxillary central incisor should be free of caries and restoration. The volunteers should have at least three teeth in occlusion in posterior segments with no overlapping, no spacing, and no crowding in the anterior teeth, having an esthetically acceptable overjet and overbite with no discolorations and structural anomalies. The exclusion criteria for the study included any history of surgery in facial area, history of neurological disorders, in ability, or unwillingness to smile and ear infections.

Diagnostic impressions of the participants were made, and then poured in dental stone following which the casts were articulated on semi-adjustable articulators (Hanau wide-vue II) after facebow transfer. The bite registrations were used to facilitate the accurate positioning of the maxillary and mandibular casts. Once the casts were mounted on the semi-adjustable articulator, the lines were drawn approximately 1 mm apical to the cementoenamel junctions of the left maxillary and mandibular central incisors. The distance between these two lines was then measured using a vernier calliper which was used to obtain the desired posterior openings. At these openings, clear acrylic material in dough stage was adapted on the occlusal surfaces from premolar to the last existing molar in the mouth. The bite splints of +2, +4, +6, and +8 mm thickness were fabricated to get the desired openings in OVD in the volunteer’s mouth while taking photographs.

The patient to be photographed was draped in gray and the entire background was kept gray. Then, the patient was made to achieve the natural head position by looking at a distant point. NHP is considered to be a reliable and repeatable head position hence used in the study.\[5,7\] Once the desired position was achieved and was confirmed, patient was made to place his/her chin on the custom-made stand, maintaining the same head position the photograph was taken. A DSLR camera (Nikon D300 with Nikon 105 mm macro lens) at a fixed focal length of 105 mm, aperture 14, ISO 200, and at a fixed patient lens at a distance of 11 inches was used for taking photographs at 0 mm OVD (with no bite splint) after asking to close gently on the back teeth, say, “M,” relax, and smile. This sequence was repeated for the successive bite splints and the photographs were obtained for data acquisition.

The photographs were imported into AutoCAD software. The photographs were imported into AutoCAD software (Autodesk Inc, US) and the following values were noted:

- Incisial edge-upper lip {The vertical distance between the midpoint of the incisal embrasure between maxillary central incisors and the upper lip}
- Incisial edge-lower lip {The vertical distance between the midpoint of the incisal embrasure between maxillary central incisors and the lower lip}
- Interlabial gap height {The vertical distance between the upper and lower lips measured at the line intersecting the midpoint of the maxillary and mandibular central incisors}
- Intercommissural width {The distance between the left and right commissures} [Figure 1].

All the measurements were made in mm. The outline of the interior border of the display zone was traced using the pen tool, and this area was recorded in mm2 [Figure 2]. Smile index (inter commissural width/interlabial gap) was also calculated. The values obtained for esthetic norms at smile were analyzed statistically by mean, standard deviation, and analysis of variance. For all the tests, \( P \leq 0.05 \) was considered statistically significant.

**RESULTS**

The values of esthetic norms at smile were tabulated and analyzed for the significance in each criteria in both male and female. The values of esthetic norms at smile were tabulated and analyzed for the significance in each criteria in both male and female.
for females, it was 6.39 mm at 0 mm without any increase in OVD. There is a statistically significant \( P = 0.04 \) in gender-wise comparison.

The maximum mean value of the incisal edge–lower lip of both male and female patients was at 8 mm increase in OVD of 9.04 mm and 10.80 mm, respectively. The least was at 0 mm without any increase in OVD with the mean of 3.87 mm and 5.39 mm, respectively. A statistically significant \( P = 0.01 \) and \( 0.03 \) was found in male and female patients, respectively, but gender-wise comparison shows not significant \( P < 0.05 \).

The mean interlabial gap height of both male and female patients is maximum at 8 mm increase in OVD with the mean of 20.44 mm and 18.19 mm, respectively. The mean interlabial gap height of both male and female patients is minimum at 0 mm without any increase in OVD with the mean of 11.75 mm and 11.76 mm, respectively. A statistically significant \( P = 0.04 \) and \( 0.01 \) were found in male and female patients, respectively, with increasing OVD for interlabial gap height, gender-wise comparison shows not significant \( P < 0.05 \).

and female patients with sequential increase of +2, +4, +6, and +8 mm OVD and also gender-wise comparison was carried out between them [Tables 1-3].

The maximum mean value of incisal edge–upper lip for both male and female patients was at 8 mm increase in OVD of 10.23 mm and 7.48 mm, respectively. The least was at 6 mm increase in OVD of 6.63 mm for males and

Table 1: Analysis of esthetic norms at smile of male patients

| Esthetic norms            | OVD (mm) | Mean±SD    | Type 3 sum of squares | df | Mean square | F   | P   |
|---------------------------|----------|------------|-----------------------|----|-------------|-----|-----|
| Incisal edge - upper lip  | 0        | 7.59±1.88  | 16.42                 | 4  | 4.10        | 0.54| 0.28|
|                           | 2        | 8.63±2.42  |                       |    |             |     |     |
|                           | 4        | 7.62±1.98  |                       |    |             |     |     |
|                           | 6        | 6.63±2.68  |                       |    |             |     |     |
|                           | 8        | 10.23±2.48 |                       |    |             |     |     |
| Incisal edge - lower lip  | 0        | 3.87±1.78  | 618.05                | 4  | 154.51      | 44.89| 0.01|
|                           | 2        | 5.87±1.90  |                       |    |             |     |     |
|                           | 4        | 7.04±1.53  |                       |    |             |     |     |
|                           | 6        | 7.78±1.89  |                       |    |             |     |     |
|                           | 8        | 9.04±2.11  |                       |    |             |     |     |
| Interlabial gap height    | 0        | 11.75±1.88 | 2097.89               | 4  | 524.47      | 98.68| 0.04|
|                           | 2        | 14.61±2.41 |                       |    |             |     |     |
|                           | 4        | 17.59±1.98 |                       |    |             |     |     |
|                           | 6        | 19.67±2.68 |                       |    |             |     |     |
|                           | 8        | 20.44±2.48 |                       |    |             |     |     |
| Intercommissural width    | 0        | 59.59±7.18 | 8.66                  | 4  | 3.92        | 0.76| 0.56|
|                           | 2        | 57.56±6.62 |                       |    |             |     |     |
|                           | 4        | 58.64±6.78 |                       |    |             |     |     |
|                           | 6        | 59.59±6.77 |                       |    |             |     |     |
|                           | 8        | 57.94±6.43 |                       |    |             |     |     |
| Internal display zone area| 0        | 605.89±210.94 | 2433459.82     | 4  | 608364.9    | 18.05| 0.03|
|                           | 2        | 657.32±150.49 |                       |    |             |     |     |
|                           | 4        | 725.32±153.37 |                       |    |             |     |     |
|                           | 6        | 835.15±167.99 |                       |    |             |     |     |
|                           | 8        | 904.02±222.76 |                       |    |             |     |     |
| Smile index               | 0        | 5.18±0.89  | 131.29                | 4  | 32.82       | 71.76| 0.02|
|                           | 2        | 4.04±0.81  |                       |    |             |     |     |
|                           | 4        | 3.36±0.45  |                       |    |             |     |     |
|                           | 6        | 3.09±0.59  |                       |    |             |     |     |
|                           | 8        | 2.98±0.52  |                       |    |             |     |     |

OVD: Occlusal vertical dimension, SD: Standard deviation, df:degree of freedom, F:F-value, P: P-value, \( P \leq 0.05 \) statistically significant

Figure 2: Display zone area tracing
The mean intercommissural width in male patients is maximum at 0 mm without any increase in OVD with the mean of 59.59 mm and least at 2 mm increase in OVD with the mean of 57.56 mm, whereas the mean intercommissural width in female patients is maximum at 6 mm increase in OVD with the mean of 60.07 mm and least at 0 mm without any increase in OVD with the mean of 59.26 mm.

\[ P = 0.56 \text{ and } 0.35 \text{ was seen in male and female patients, respectively. No statistically significant difference was found with increasing OVD for intercommissural width in the patients, but gender-wise comparison shows statistically significant } P = 0.03. \]

The mean internal display zone area of both male and female patients is maximum at 8 mm increase in OVD with the mean of 904.02 mm\(^2\) and 836.22 mm\(^2\), respectively, and minimum at 0 mm without any increase in OVD with the mean of 605.89 mm\(^2\) and 516.05 mm\(^2\), respectively. A statistically significant \( P = 0.03 \) and 0.001 were found in male and female patients, respectively, with increasing OVD for internal display zone area, but gender-wise comparison revealed \( P < 0.05 \).

The mean smile index of both male and female patients is maximum at 0 mm without any increase in OVD with the mean of 5.18 and 5.19, respectively, and minimum at 8 mm increase in OVD with the mean of 2.98 and 3.36, respectively. A statistically significant \( P = 0.02 \) was found in both male and female patients with increasing OVD for smile index, but gender-wise comparison revealed \( P < 0.05 \).

**Discussion**

A prosthodontist’s major goal for all occlusal treatment is to develop harmony in the masticatory system and achieve good esthetics. Adaptive response in the system elicits to equilibrium

### Table 2: Analysis of esthetic norms at smile of female patients

| Esthetic norms      | OVD (mm) | Mean±SD     | Type 3 sum of squares | DF | Mean square | F    | P     |
|---------------------|----------|-------------|-----------------------|----|-------------|------|-------|
| Incisal edge-upper lip | 0        | 6.39±2.01   | 9.60                  | 4  | 7.41        | 1.82 | 0.12  |
|                     | 2        | 6.69±2.09   |                       |    |             |      |       |
|                     | 4        | 6.69±2.01   |                       |    |             |      |       |
|                     | 6        | 7.15±1.89   |                       |    |             |      |       |
|                     | 8        | 7.48±2.06   |                       |    |             |      |       |
| Incisal edge-lower lip | 0        | 5.39±0.97   | 643.92                | 4  | 160.98      | 40.55| 0.03  |
|                     | 2        | 8.01±1.53   |                       |    |             |      |       |
|                     | 4        | 8.89±1.90   |                       |    |             |      |       |
|                     | 6        | 9.37±2.24   |                       |    |             |      |       |
|                     | 8        | 10.80±2.82  |                       |    |             |      |       |
| Interlabial gap height | 0        | 11.76±2.19  | 923.53                | 4  | 230.88      | 30.66| 0.01  |
|                     | 2        | 14.69±2.52  |                       |    |             |      |       |
|                     | 4        | 15.49±2.45  |                       |    |             |      |       |
|                     | 6        | 16.44±2.82  |                       |    |             |      |       |
|                     | 8        | 18.19±3.54  |                       |    |             |      |       |
| Intercommissural width | 0        | 59.26±5.38  | 18.14                 | 4  | 4.53        | 0.14 | 0.35  |
|                     | 2        | 59.62±5.8   |                       |    |             |      |       |
|                     | 4        | 59.82±5.95  |                       |    |             |      |       |
|                     | 6        | 60.07±5.17  |                       |    |             |      |       |
|                     | 8        | 59.36±6.01  |                       |    |             |      |       |
| Internal display zone area | 0        | 516.05±121.74 | 2399544.16          | 4  | 599886.04   | 45.76| 0.001 |
|                     | 2        | 634.22±113.37 |                       |    |             |      |       |
|                     | 4        | 683.32±143.93 |                       |    |             |      |       |
|                     | 6        | 741.19±115.45 |                       |    |             |      |       |
|                     | 8        | 836.22±125.40 |                       |    |             |      |       |
| Smile index          | 0        | 5.19±1.04   | 75.06                 | 4  | 18.77       | 27.86| 0.02  |
|                     | 2        | 4.14±0.76   |                       |    |             |      |       |
|                     | 4        | 3.92±0.69   |                       |    |             |      |       |
|                     | 6        | 3.77±0.88   |                       |    |             |      |       |
|                     | 8        | 3.36±0.97   |                       |    |             |      |       |

OVD: Occlusal vertical dimension, SD: Standard deviation

### Table 3: Gender-wise comparison of esthetic norms at smile

| Esthetic norms                          | Mean difference | \( t^* \) | \( P \) |
|-----------------------------------------|-----------------|-----------|--------|
| Incisial edge-upper lip                 | 1.468           | 2.31      | 0.04 (S) |
| Incisial edge-lower lip                 | 1.772           | 1.23      | 0.42 (NS) |
| Interlabial gap height                  | 1.534           | 2.27      | 0.08 (NS) |
| Intercommissural width                  | 1.094           | 2.35      | 0.03 (S) |
| Internal display area zone              | 63.34           | 4.63      | 0.48 (NS) |
| Smile index                             | 0.35            | 2.69      | 0.27 (NS) |

*Unpaired \( t \)-test, \( P<0.05 \), S: S Significant, NS: Not significant
when occlusal disharmony prevails. The adaptive process may be beneficial but not always predictable. An increased vertical dimension, while adaption may cause the lengthened teeth to intrude into the alveolar bone to regain the original jaw-to-jaw relationship or there may be an attempt to wear away the increased dimension by bruxing. There is increased loading on the lengthened teeth from muscle that is attempting to regain its normal length of contraction, and if the added compression of the supporting tissues exceeds their capacity to remodel acceptably, we will see hypermobility of the teeth and a lowered resistance in the periodontal structures.[10] However, according to Bloom and Padayachy,[7] esthetics is one of the rationales for altering OVD. Mohindra and Bulman[9] also suggested to increase the lower facial height before going for cosmetic surgery. Frank Spear[7] after reviewing stated that the position of vertical dimension is highly adaptable and none of the methods determine the correct vertical dimension, so it would be better to establish the one that suits the patient’s esthetics and also that meets clinician’s functional goals. They have mentioned steps to determine the vertical dimension and alter it. Abduo and Lyons[10] again mentioned esthetics as one of the determinants for increasing OVD, and this procedure is safe with subsequent signs and symptoms which would be self-limiting, provided the increase in OVD is minimum thus reducing the complex prosthetic treatment. They also objected to wearing in TMD-free patients as they may have signs and symptoms related to it rather than OVD increase.

In the present study, the effect of sequential increase in OVD on the esthetics norms includes the vertical distance between the incisal edge–upper lip, vertical distance between incisal edge–lower lip, interlabial gap height, intercommissural width, internal display zone area, and smile index were evaluated. To assess those criteria the digital image of each patient was taken and then calculated in AutoCAD software.

Images obtained in the study followed the principles of facial photography by Milosevic et al.[11] ADSLR camera has been preferred for the high-quality photograph documentation. A focal length of 90–105 is advised for dental photography.[12] About 100 mm focal length was used in this study for minimum distortion and maximum depth of field.

Position of patient for photography is critical. One of the tested methods for orientation of the head is the “natural position of the head,” which was defined by Broca in the 19th century as the standing position, which can be achieved when the patient is looking at a distance, this was in accordance with Lundstrom. Other methods include looking in a natural posture into a mirror and hung on the wall at eye level.[13] The natural head position can be marked using a spirit level device based on the principle of physics which underlines the fluid levels. It states that in a nonaccelerating fluid system (hydrostatic), the surface of a liquid is horizontal. The fluid surface tends to align at right angles to the force of gravity.[13] The device used in the study operates on this principle.

Tjan defined the “average smile” as one that reveals 75%–100% of the maxillary anterior teeth and interproximal gingiva.[14] Hulsey found that patients 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.[15] Frey, in his case report, claimed that increasing the vertical dimension increases the crown-to-gum ratio and effectively decreases the gummy smile.[16] Vig and Brundo in their study found the average maxillary incisor display in men and women as 1.91 mm and 3.40 mm, respectively.[6] The another study was done by Ackerman, he found the maximum incisor exposure at posed smile to be 6.36 ± 1.67 mm.[1] Van der Geld in his study on age-related differences at rest and smile position found the rest position of the upper lip to maxillary central incisor decreased from 5.5 mm to 2.0 mm.[17] Misch in his study observed the vertical exposure of maxillary incisors at repose for females having an average value of 3.8 mm and males having an average value of 2.5 mm.[18] In a study conducted by Desai, it was concluded that incisal edge display decreased with increasing age.[19] Chetan et al. in their study found the changes in upper lip length from rest to smile decreased by 5.58% in males and by only 1.31% in females.[20] In a study done by Hu, it was observed that frequencies of gingival display in the central incisor region for women and men were 42% and 28%, respectively.[21] The results of the present study show an increase in maxillary incisor display in both female and male patients with increase in OVD, whereas a statistically significant difference with respect to both the patients were observed. This suggests that during treatment planning it should be noted that, the upper lip at smile is not to be expected to move down with increase in OVD.

An evaluation was done on the effect of increasing OVD on the lower facial height in dental students aged 26–40 years by Gross, who concluded that there is no visual apparent changes in soft-tissue face height when changes in OVD in fixed prosthodontics treatment ranges between 2 and 6 mm, but observed a change of +4 mm in lower face height with +8 mm increase in OVD.[22] Chou et al. conducted a study and found a +5.17 mm increase in incisal edge–lower lip distance with increase in OVD.[23] But in the present study, statistically significant increase in incisal edge–lower lip at smile is observed in all patients with an increase in OVD.

With the increase in vertical dimension of occlusion, the separation between the maxilla and the mandible are also increased eventually. Hence, it is probable that the upper and lower lips positions will also change during smiling. Ackerman evaluated the smiles of 50 young patients with a mean age of 12.5 years and he found the interlabial gap at posed smile was found to be 8.41 ± 2.10 mm.[14] McNamara et al. studied esthetics of posed smile in growing patients using video analysis, they found the average interlabial gap height to be 10.4 ± 3.7 mm.[24] Desai et al. evaluated the changes in smile, with respect to age and found the mean interlabial gap height for age group 20–29 years as 10.42 mm.[19] Chou et al. in their study found interlabial gap height at rest to be 10.42 ± 3.28 mm.[23] In the present study, also there is statistically significant increase in the interlabial gap height in all patients with increase in OVD.
The movement of the corners of the mouth is dictated by the modiolus, where eight muscles meet, among which the zygomaticus major and the triangularis muscles are of prime concern, as they are inserted into the zygomatic arch and the mandible, respectively. Thus, by increasing the OVD, it is possible that the distance between the corners of the mouth will be altered. McNamara et al. in their study on esthetics of posed smile found the average intercommissure width as 61.1 ± 5.4 mm.[24] Chetan et al. conducted a study to determine the age and gender differences in measurements of smile and concluded that there was a decrease in intercommissural width from rest to smile and also with increasing age in both males and females.[20] Chou et al. in their study found intercommissural width at rest to be 62.90 ± 4.17 mm.[23] The results obtained in this study showed slight decrease in intercommissural width with an increase in OVD in all patients, but there is statistically significant difference between male and female patients.

Ackerman described the “display zone” as the area framed by the upper and lower lips.[1] Chou et al. in their study found display zone area of 509.08 ± 190.08 mm² at +0 mm OVD.[21] In this study, there is high standard deviation thus indicating a considerable amount of variability in display zone area among different patients. A statistically significant increase in display zone area was found in both male and female patients with increasing OVD.

According to Desai et al., an increase in smile index was observed with increasing age, which progressed from 5.63 in 15–19-year-old age group to 8.05 in 50-year-old people.[19] Chou et al. found smile index at +0 OVD to be 6.58 ± 1.92 which decreased to 4.38 ± 1.29 at +8 mm OVD. He also summarized that a clinical decision can be made for altering OVD using the age-related pretreatment smile index average values.[23] In the present study, an increase in OVD led to a decrease in the smile index, thus signifying that OVD has a profound influence on smile index. Thus, data obtained from the dentulous patients will serve as guide to use those average values to achieve natural esthetics in full mouth rehabilitation patients as well as in edentulous patients.

**Conclusion**

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

A statistically significant increase in incisal edge to lower lip distance, interlabial gap height, and display zone area was found in both male and female patients with increased OVD. The smile index decreased with increased OVD in both male and female patients. A change in the intercommissural width and a change in the length of the upper lip at smile should not be expected with an increase in the OVD in male and female patients.

These esthetic norms of smile of this study can be useful in treatment of cases where there is loss of vertical dimension and an increase in OVD is desired or to improve the facial esthetics in patients. The digital photography for evaluation of those norms was found to be a helpful aid and easier approach for diagnosis and treatment planning.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Ackerman MB, Ackerman JL. Smile analysis and design in the digital era. J Clin Orthod 2002;36:221-36.
2. Shillingburg HT Jr., Hobo S, Whitset LD. Fundamentals of Fixed Prosthodontics. 3rd ed. Chicago, Ill: Quintessence; 1957. p. 419-20.
3. Abduo J. Safety of increasing vertical dimension of occlusion: A systematic review. Quintessence Int 2012;43:369-80.
4. Koough B. Occlusion-based treatment planning for complex dental restorations: Part 1. Int J Periodontics Restorative Dent 2003;23:237-47.
5. Dawson PE. Functional Occlusion: From TMJ to Smile Design. Mosby: Elsevier Health Sciences; 2006.
6. Vig RG, Brundo GC. The kinetics of anterior tooth display. J Prosthet Dent 1978;39:502-4.
7. Bloom DR, Padayachy JN. Increasing occlusal vertical dimension – Why, when and how. Br Dent J 2006;200:251-6.
8. Mohindra NK, Bulman JS. The effect of increasing vertical dimension of occlusion on facial aesthetics. Br Dent J 2002;192:164-8.
9. Spear FM. Approaches to vertical dimension. Adv Esthet Interdiscip Dent 2006;2:2-12.
10. Abduo J, Lyons K. Clinical considerations for increasing occlusal vertical dimension: A review. Aust Dent J 2012;57:2-10.
11. Milosevic SA, Slaj M, Varga ML. Basic principles for taking extraoral photographs. Acta stomatol Croat 2005;39:201-4.
12. Vargas MA. Photographs of the face for publication and presentations. J Prosthodont 2003;12:47-50.
13. Showfety KJ, Vig PS, Matteson S. A simple method for taking natural-head-position cephalograms. Am J Orthod 1983;83:495-500.
14. Tjkan AH, Miller GD, The JG. Some esthetic factors in a smile. J Prosthodont 1984;51:24-8.
15. Hulse CM. An aesthetic evaluation of lip-teeth relationships present in the smile. Am J Orthod 1970;57:132-44.
16. Frey DS. Bite alteration for reducing gummy smiles: Two case reports. Cosmet Dent Engl 2010;4:18-22.
17. Van der Geld P, Oosterveld P, Kuijpers-Jagtman AM. Age-related changes of the dental aesthetic zone at rest and during spontaneous smiling and speech. Eur J Orthod 2008;30:366-73.
18. Misch CE. Guidelines for maxillary incisal edge position-a pilot study: The key is the canine. J Prosthodont 2008;17:130-4.
19. Desai S, Upadhyyay M, Nanda R. Dynamic smile analysis: Changes with age. Am J Orthod Dentofacial Orthop 2009;136:310.e1-10.
20. Chetan P, Tandon P, Singh GK, Nagar A, Prasad V, Chugh VK, et al. Dynamics of a smile in different age groups. Angle Orthod 2013;83:90-6.
21. Hu X, Nahles S, Nelson CA, Lin Y, Nelson K. Analysis of soft tissue display during enjoyment smiling: Part 1 – Caucasians. Int J Periodontics Restorative Dent 2013;33:69-15.
22. Gross MD, Nissan J, Ormianer Z, Dvori S, Shifman A. The effect of increasing occlusal vertical dimension on face height. Int J Prosthodont 2002;15:353-7.
23. Chou JC, Thompson GA, Aggarwal HA, Bosio JA, Irelan JP. Effect of occlusal vertical dimension on lip positions at smile. J Prosthet Dent 2014;112:533-9.
24. McNamara L, McNamara JA Jr. Ackerman MB, Baccetti T. Hard- and soft-tissue contributions to the esthetics of the posed smile in growing patients seeking orthodontic treatment. Am J Orthod Dentofacial Orthop 2008;133:491-9.