The Effect of Increasing Occlusal Vertical Dimension on Face Height

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Purpose: This study evaluated the effect of increasing occlusal vertical dimension (OVD) on the face height in completely dentate young adults. **Materials and Methods:** Faces of 22 subjects were photographed in a standardized manner in an anterior view. Sequential photographs were taken at intercuspation and clinical rest position, with four complete-arch maxillary occlusal overlays increasing OVD in interincisal increments of 2, 4, 6, and 8 mm. Objective measurements were made from the photographs using facial reference markers. Ten observers made subjective evaluations of the resulting changes in face height using the sequential photographs randomly presented. **Results:** Measurements of the facial markers showed that on increasing OVD, a corresponding change in lower face height was 50% of the interincisal increase in intercuspation and 40% for clinical rest position. ANOVA for repeated measures showed a statistically significant effect of the intraoral increase in OVD on lower face height. However, subjective results showed that observers were not capable of detecting changes in face height caused by an intraoral increase in OVD (2 to 6 mm intrinsically). ANOVA for the difference between dentists and nondentists showed a minimal, but significant, difference between the two groups, with dentists erring slightly less. **Conclusion:** Attempts to alter face height by changing OVD within the range of 2 to 6 mm for esthetic reasons may not be visually distinguishable. *Int J Prosthodont 2002;15:353–357.*

A common belief in fixed and removable prosthodontics is that an increase or decrease in the occlusal vertical dimension (OVD) significantly affects the lower face height and facial esthetics.[1–3] Some believe that an altered OVD can improve dentofacial esthetics and create improved visual proportions in facial height.[3] Face height is subject to normal variation within and between racial types.[4–6] Attempts have been made to create normative values of facial proportions according to the esthetic values of ancient Greece.[5,7] Standard values of 1:1.6 of middle to lower facial proportions have been described as a "golden proportion," but these remain subjective and highly empirical. In a study on facial proportions conducted on 50 females rated as attractive in a US beauty pageant, the mean chin height was $^1/_5$ of the face height and the visible eye was $^1/_4$ of the face height.[8] These assessments of attractiveness are usually made with the subject smiling.[9]

While significant loss or excess of OVD manifests as obvious shortening or lengthening of the lower face height, it is not clear in what range or to what degree more subtle changes in OVD manifest in noticeable changes of face height. The working hypothesis of this study was that changes in OVD would cause a corresponding increase in lower face height. The purpose of this study was to evaluate the effect on the face height of increasing OVD in completely dentate

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This study was presented at the Eighth Biannual Meeting of the International College of Prosthodontics, July 1999, Stockholm.

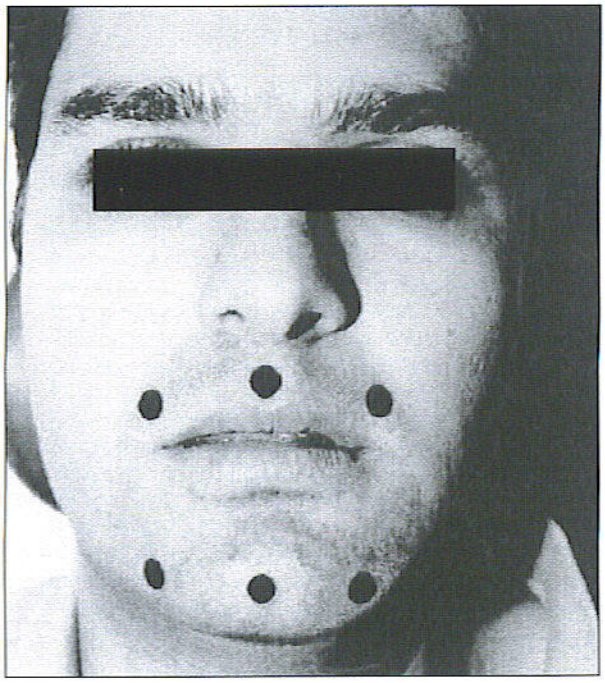


Fig 1 Anterior view of subject at rest. Facial reference markers are used to measure changes in lower face height.

young adults at maximum intercuspation position (MIP) and clinical rest position by objective measurement of facial soft tissue markers and by subjective evaluator assessment.

Materials and Methods

From a sophomore dental class, 22 subjects (13 men and nine women) were randomly selected. Names were arbitrarily selected from a list by an independent observer. Ages ranged from 26 to 40 years (mean 28.5 years). All subjects had intact dentitions, no facial abnormalities, and no signs or symptoms of temporomandibular disorders.

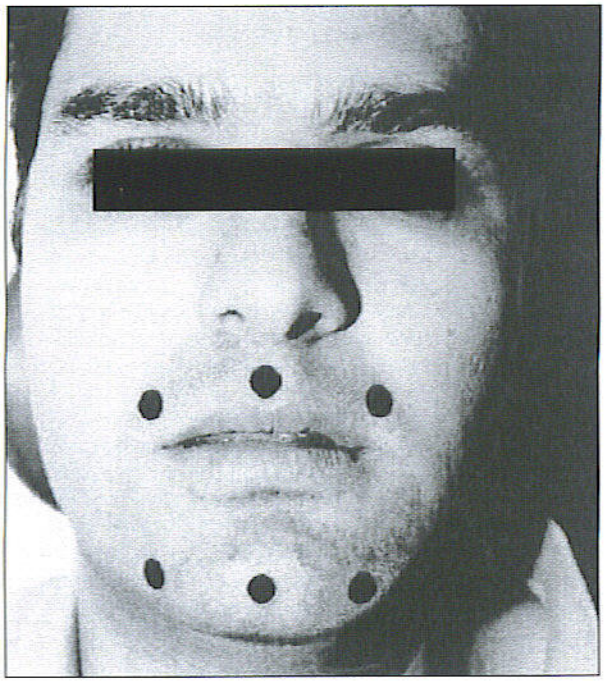
Irreversible hydrocolloid complete-arch impressions were made of each subject, and the maxillary model was mounted on a Hanau H2 articulator (Hanau Teledyne) using an arbitrary hinge-axis facebow. Mandibular casts were related to the maxillary casts in the intercuspal relation using wax interocclusal jaw registrations. Complete-arch occlusal overlays were fabricated from autopolymerizing acrylic resin (Justys acrylic) on the maxillary casts. Overlays were made continuous with buccal and lingual contours with minimum bulk to avoid interference with buccal or lingual soft tissues. Occlusal contact was designed to provide simultaneous complete-arch contact on closure in centric jaw relation. Separate overlays were made at interincisal distances of 2, 4, 6, and 8 mm on the mounted casts for each subject. This distance was clinically verified with calipers from the maximum apical gingival contour of the maxillary and mandibular right central incisors. Overlays were adapted intraorally, and the occlusion was refined until each subject could close into the intercuspal relation with ease.

Photography

Each subject was seated on a vertically inclined chair with a well-contoured headrest to support the head. A reflex camera was set up on a tripod at a fixed distance facing the subject, with the focal length and lens adjusted to produce photographic prints of 1:1 ratio. Subjects were photographed in a standardized manner in an anterior view. Each subject was photographed with the mandible closed against the maxilla in MIP and at clinical rest position, which was determined by the command method.[10] Successive photographs were taken on closure (MIP), at rest, and then with four removable overlays (increasing OVD by 2, 4, 6, and 8 mm) as described above.

Six arbitrary reference markers were adhered to the subject's face (Fig 1). The central reference markers were used to measure extraoral vertical dimensions. Outer and central reference markers were used to test for potential distortions between facial photographs. An independent observer measured the distance between upper and lower and between left and right outer markers on each seated subject prior to photography. This was done with a digital caliper for comparison with the photographic images.

Before initial photographs, the distance between the two midline central markers and the outer upper markers was measured for each subject. For recordings in MIP, the subject was instructed to close in MIP and look directly ahead. On subsequent exposures, the subject placed the appropriate occlusal overlay, taking care not to move the head, and closed in MIP. Resting face height was established at clinical rest position by the command method, with the subject instructed to close in MIP, relax the jaw and facial muscles, and look directly ahead.[10] Photographs were exposed after 5 seconds. Immediate recordings with the mandible at rest were made based on studies reporting the immediate establishment of a new postural relation after placement of interarch devices.[11,12] After the initial photograph, the subject was instructed to place the appropriate occlusal overlay without head movement, and the process was repeated. The subject was not aware which overlay he or she was receiving. Overlays were placed in the sequence of 2, 4, 6, and 8 mm.



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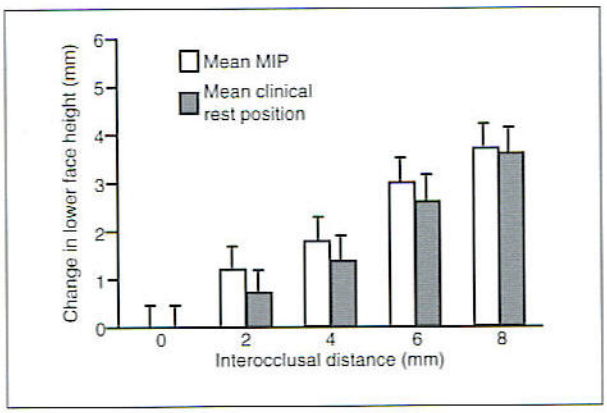

Fig 2 Mean vertical increase in lower face height in MIP and clinical rest position with progressive incremental increase in OVD from 2 to 8 mm. Vertical lines denote SDs.

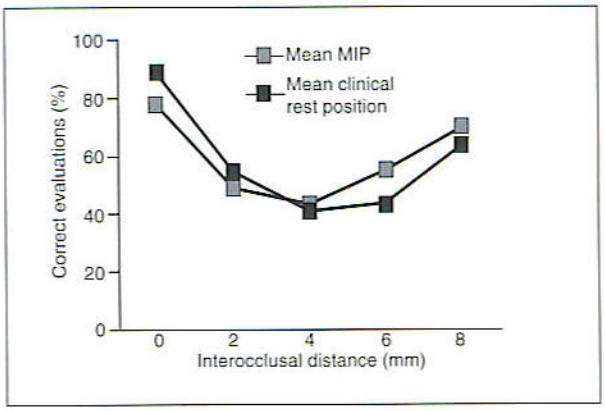

Fig 3 Percentage of correct evaluations of face height from unmarked photographs by 10 observers for subjects with incremental increase in OVD from 2 to 8 mm. Interocclusal distance measured interincisally.

For each subject, a series of five photographs were taken in MIP with facial reference markers, followed by a series of five photographs in rest position. Markers were removed, and a further series was exposed in MIP and rest position with the appropriate maxillary overlays.

Objective Measurements

Photographic prints were made in a 1:1 ratio, taking care to ensure standardized printing dimensions. In each photograph, for comparative assessment of the lower face height, one person measured the distance from the inferior border of the maxillary midline marker to the superior border of the mandibular midline marker. Additional vertical and horizontal measurements of left and right markers were made to check for consistency of facial position between exposures. Comparison was made between the prephotographic recordings and the photographic image without overlay.

Subjective Assessment

Separate unmarked MIP and clinical rest position series of photographs of each subject without facial markers were randomly presented to 10 observers. Photographs were shuffled, face downward, for 30 seconds by a dental assistant who was unaware of their content and purpose and handed in this order to each observer. This was repeated for each observer with each series of photographs. Observers were randomly selected from staff members according to availability (five dentists and five nondentists). Each was asked to arrange each series in ascending order of face height from minimum to maximum for all subjects. Photographs were marked in pencil in the upper right hand corner in code on the reverse side for blind testing.

Statistical Analysis

Analysis of variance (ANOVA) with repeated measures was carried out for objective and subjective evaluations. For the objective measurement, ANOVA was used to compare the effect of appliance thickness with vertical intermarker distance. For the subjective evaluation, ANOVA was used to compare the percentage of correct evaluation against appliance thickness.

Results

The objective measurements showed a linear increase in lower face height of 50% of the interincisal incremental increase in OVD for MIP. For clinical rest position, a similar linear increase of lower face height occurred as 40% of the increase in OVD (Fig 2). ANOVA for repeated measures showed a statistically significant effect of increase in OVD ($P < .0001$), a significant effect of MIP or rest position on lower face height ($P < .0001$), and no interaction between increase in OVD and face height for both MIP and clinical rest position ($P > .48$). Thus, with each progressive increase in OVD, a corresponding increase that was significantly smaller ($P < .0001$) than the interincisal increase occurred in face height for both MIP and rest position.

The mean difference between upper and lower midline markers between subject and photograph was 0.17 mm (standard deviation [SD] 0.15), and 0.05 mm (SD 0.07) between upper outer markers. The mean maximum difference between upper outer

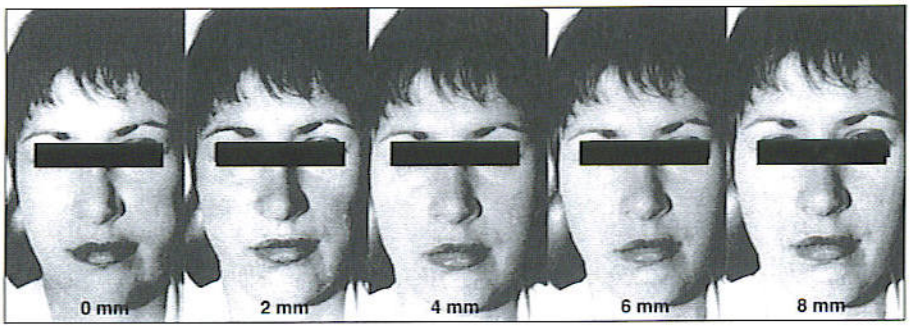

Fig 4a Anterior views of subject in MIP with OVD increased in interincisal distance increments of 2 mm (in ascending order from left to right).

Fig 4b Anterior views of subject in clinical rest position with OVD increased in interincisal distance increments of 2 mm (in ascending order from left to right).

facial markers in photographs at successive vertical dimensions was 0.11 mm (SD 0.06), and 0.12 mm (SD 0.06) between lower outer facial markers. For subjective assessment, the highest percentage of correct answers was for subjects without the overlays and with the 8-mm overlay for both MIP and rest position. Lowest values were recorded for 2-, 4-, and 6-mm overlays, with very little difference in percentage of correct evaluations (Fig 3). Observers were unable to distinguish changes in face height in the ranges of 2, 4, and 6 mm for both MIP and rest position. ANOVA for repeated measures showed a significant relation between the change in OVD and the accuracy of observer evaluation ($P < .0001$), no significant difference between MIP and rest position, and no interaction between the accuracy of observer evaluation and the change in OVD.

ANOVA for difference between dentists and nondentists showed a significant difference between the two groups ($P = .0015$), with dentists erring less. Photographs of a subject with OVD increase in interocclusal distance increments of 2 mm for both MIP and rest position demonstrated the difficulty in subjectively discerning changes in face height at varying OVDs (Fig 4).

Discussion

Principal findings of this study showed that changes in lower face height were smaller than the interincisal increase in OVD and that increase in OVD between 2 and 6 mm was not readily apparent when viewed in an anterior direction. The increase in face height was half the value of the interincisal opening because of the occlusal appliance. This might be explained by facial soft tissue compensation, with changes in lip and mentalis tonus. In several subjects, there was no corresponding increase in vertical reference marker measurements as the interincisal OVD increased from 0 to 8 mm. A direct correlation of face height to dentoalveolar changes has generally referred to hard tissue or cephalometric reference points.[3,13–16] Thus, when assessing changes in face height, a distinction should be made between hard and soft tissue reference points. Subtle changes in face height with age or from tooth attrition using cephalometrics or dry skull measurements have been reported.[13–16] It is not clear whether these changes are apparent in normal soft tissue facial morphology and appearance.[17] The present study showed that changes in OVD in the 2- to 6-mm range were not readily apparent on facial appearance. Thus, clinical concepts

extrapolating hard tissue reference findings to soft tissue facial form are unfounded.

The reliability and accuracy of the recordings in this study were ensured by a correlation of the true subject and image dimensions and by no distortion of facial dimension change caused by head movement. Other studies used fluid level devices attached to the head to ensure stable head posture for cephalometric recordings.[18,19]

Clinical rest position was used as the reference postural relation because of the difficulty and inconsistency of measuring physiologic rest position. The assumption that a new clinical rest position occurs immediately after placement of the occlusal overlays was based on earlier studies[11,12] showing an immediate establishment of a new postural relation with interarch devices. This was supported by the linear increase in clinical rest position measurements for all subjects seen in this study.

The concept of long-term adaptation of mandibular posture to increased OVD with fixed restorations in the interincisal range of 2 to 10 mm is becoming more accepted.[11,12,20–23] However, results from this study suggest that in the 2- to 6-mm range, facial changes may not be readily apparent. Contrary to some predictions,[3] clinicians cannot necessarily expect a corresponding increase in lower face height from an OVD increase of even 6 mm in dentate subjects. These results apply only to increased OVD from a normal starting point. Severely diminished or excessive OVD may not behave in a similar manner.

Occlusal plane location[3,5] and facial changes[14] are additional factors influencing clinical restoration of crown length and its relation to soft tissue facial height. There is also a general morphologic change in facial form associated with both tooth wear and the aging process, with changes in lip and chin morphology. Findings of this study apply to young adults. Changes in older patients may be more apparent because of aging-induced soft tissue alterations. Simple restoration of crown height, even at an increased OVD, may not completely reverse the facial appearance of overclosure.[14] Findings of the present study indicate that changes in OVD in fixed prosthodontics within the range of 2 to 6 mm are unlikely to cause visually apparent changes in the soft tissue face height in the range of normal OVD.

Acknowledgment

The authors thank Ms Rita Lazar for editorial assistance.

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