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# The association between dental wear and reduced vertical dimension of the face: A morphologic study on human skulls

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ABSTRACT

*Objective:* The aim of this study was to explore the relationship between dental wear and facial morphology, with particular reference to the occlusal vertical dimension, in modern human skulls.

*Design:* One hundred and three skulls (52 men and 51 women) between the ages of 20 and 50+ years old were studied. The selected skulls were from a modern period (the 17th and the 18th centuries) and included at least one entire condyle and had at least 3 posterior teeth (premolar or molar) in each quadrant to allow for dental articulation. Occlusal wear was evaluated using ordinal scale (0–4) and vertical occlusal dimension was evaluated by measuring upper facial height (UFH), lower facial height (LFH), LFH-to-UFH ratio (L-U-R) and dental wear. Based on the occlusal wear score, two groups were defined: with and without significant wear.

*Results:* Significant relation was observed between age and dental wear ($P < 0.01$). No significant differences were found in the LFH ($P = 0.847$) or UFH ($P = 0.108$) between the two wear groups. In addition, no significant difference ($P = 0.132$) was demonstrated in the LFH-to-UFH ratio between the groups. No difference was observed in the dental wear score between genders ($P = 0.321$).

*Conclusion:* Within its limitations, this study demonstrated that dental wear does not influence the vertical dimension of occlusion. Our assumption is that the dento-facial complex fully compensates for the dental effects of wear throughout life.



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## 1. Introduction

Dental wear, both of the occlusal or proximal surfaces, is inevitable and results from physiological and pathological factors.[1] Evidence from anthropological studies has suggested that severe tooth wear might not only affect the teeth and occlusion, but it might also have more wide-ranging effects on overall dento-facial morphology.[2,3] Since studies based on contemporary subjects have confirmed these findings,[4] it is believed that the adult dento-facial complex is not a static entity but could compensate for some of the dental effects of wear.

There has been increasing acceptance that tooth wear rarely occurs as a result of one factor alone and that the wear observed in any individual might be the result of a combination of all the possible etiological factors over the lifetime of the dentition. In archaic populations, the usage of teeth as tools was mostly common.[5,6] In addition, environmental factors, such as the presence of grit in an unrefined diet and the consistency of food, can affect the extensiveness of occlusal wear.[7] In modern subjects, erosive dietary factors, the use of abrasive dental hygiene tools and abnormal tooth contacts due to bruxism are the main reasons for dental wear (erosion, abrasion and/or attrition).[8]

It has been demonstrated that the effects of the loss of tooth tissue through wear are not restricted to the teeth themselves, but they are also more widespread throughout the face.[4] Facial height is measured with the teeth in occlusion and it can be subdivided into upper and lower components, corresponding to above and below the maxillary basal bone.[7] Lower facial height (or occlusal vertical dimension – OVD) could be expected to be affected by tooth wear, because it is the part of the face that contains the dento-alveolar structures, whereas the upper facial height is determined by genetic and airway considerations and is thus less likely to be influenced by tooth wear.

The role of compensatory mechanisms, which can occur in response to tooth wear and can affect facial height, remains controversial. In 1959, Murphy[9] studied Australian aboriginal skulls and found some loss of facial height due to severe dental wear. He stated that a compensatory mechanism for some of this severe tooth wear might have included continuous tooth eruption and generalized alveolar bone growth. His conclusion was that the compensation was not fully adequate, and the net result was a decrease in facial height. The change in facial height due to wear was also investigated in detail by Tallgren[10] in living subjects. She studied the changes in adult face height that occurred in association with tooth wear and found that the lower face height was markedly less in a group with advanced wear, compared to age-matched controls. Varrella[3] studied a Finnish skulls population of the 15th century and concluded that severe tooth wear produced a reduced angle between the body and ramus (gonial angle) and consequently a smaller anterior face height. To provide information more relevant to a modern population, Krogstad and Dahl[11] conducted a similar study on a group of adult Norwegians with advanced tooth wear. Their findings showed that the mandible was more horizontal, the gonial angle was more acute, and the lower face height had smaller values than in a normal adult cohort. All the above studies rejected the theory of a compensatory mechanism that fully compensates for severe dental wear.

In contrast to the above studies, Crothers and Sandham[12] showed no significant differences in total face height between living subjects who had advanced dental wear and those who had no signs of severe generalized tooth wear. It was concluded that dento-alveolar development contributes to the maintenance of total facial height, thereby fully compensating for loss of vertical height through severe dental wear.

According to Dawson's theory, the mandible-to-maxilla relationship, established by the repetitive contracted length of the elevator muscles, determines the OVD. Therefore, in subjects with severe dental wear, the process of continual addition of layers of cementum to the root and concurrent elongation of the alveolar process throughout life fully compensate for the worn dentition.[13]

The aim of this study was to explore the relationship between dental wear and facial morphology, with particular reference to the occlusal vertical dimension, in modern human skulls.

The null hypothesis was that severe dental wear would reduce the lower facial height (OVD) and thus would affect facial morphology.

## 2. Materials and methods

Skulls were selected from the anthropological collection of the Faculty of Medicine at Tel Aviv University. This collection was excavated from several Bedouin burial sites throughout Israel and from burial sites throughout India. Skulls were included in the study if they were relatively undamaged, had at least one entire condyle and had at least three posterior teeth (premolar or molar) in each quadrant to allow for dental articulation and scoring of the level of wear. Skulls from individuals younger than 20 years old were excluded.

Out of 550 skulls surveyed, 103 fulfilled the inclusion criteria (52 men [50.5%] and 51 women [49.5%]). All the selected skulls were from the modern period (the 17th and the 18th centuries): 78 of Bedouin origin [75.7%] and 25 of Indian origin [24.3%].

The sex of each sample was determined according to the skull and pelvic morphology and measurements of the long bones.[14] The estimation of age at the time of death was based on epiphyseal closure stages[15] and on chronological changes in the pelvic joints (symphysis pubis and auricular surface).[16] The age range of the skulls at the time of death was 20–50+ years old. The sample was divided into 3 groups: A = 20–34 years old; B = 35–49 years old; and C = 50+ years old.

For the facial height measurements, the skulls were held with the jaws centrally occluded and were fixed with sticky wax, while electronic millimetre calliper was used. Total facial height (nasion to gnathion) was subdivided into two components: upper facial height (nasion to nasospinale – UFH) and lower facial height (nasospinale to gnathion – LFH), according to Murphy[9] (Figs. 1 and 2). All measurements were evaluated twice to ensure accuracy by the same examiner.

Dental wear was evaluated using the Eversole et al.[17] criterion which was a modification of the wear extent scale