



# Anatomical changes in the structure of the temporomandibular joint caused by complete edentulousness

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## Anatomical changes in the structure of the temporomandibular joint caused by complete edentulousness

**Background:** The posterior slope of the articular eminence of completely edentulous patients compared to patients with maintained occlusion shows significant flattening.

**Objective:** The aim of this present study was to reveal a possible correlation between edentulousness and the flattening of the eminence and to find out whether this deformation is connected to age.

**Material and methods:** Thirty patients were examined in three groups, each consisting of 10 persons (group I: 18- to 25-year-old patients with maintained occlusion, group II: patients over 60 with maintained occlusion, group III: edentulous patients over 60). The three groups were compared according to dental status, age, sex and side. Measurements were carried out on orthopantomographic images taken with Kodak 8000 Digital Panoramic System. The angle of the posterior slope of the articular eminence relative to the Frankfort plane was measured on both sides. Data were analysed statistically with the one-way ANOVA test ( $\alpha = 0.05$ ).

**Results:** The highest values were measured in group I (right side:  $39.8 \pm 5.4^\circ$ , left side:  $43.0 \pm 5.9^\circ$ ), values were somewhat lower in group II (right side:  $38.9 \pm 4.7^\circ$ , left side:  $39.5 \pm 7.4^\circ$ ) and were the lowest in group III, which was significantly lower on both sides than the results of group I and group II (right side:  $29.8 \pm 6.0^\circ$ , left side:  $31.9 \pm 5.2^\circ$ ,  $p < 0.01$ ). The correlation coefficient between age and the flattening of the eminence in group I, II and III was 0.23, 0.35 and 0.92, respectively.

**Conclusion:** The flattening of the articular eminence could be correlated with age; however, the rate of deformation is significantly higher in completely edentulous patients than in patients with maintained occlusion.

**Keywords:** elderly, complete edentulousness, condyle of the mandible, articular eminence, condylar inclination.

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## Introduction

According to the statistics, the elderly population of the civilised world has increased remarkably during the previous decades. Twenty-three per cent of the Hungarian population was older than 60 years at the time of an epidemiological survey in October 2000<sup>1</sup>. To provide an effective therapy for these patients, clinicians first need to be aware of the age-related changes in the stomatognathic system and the possible consequences of complete edentulousness.

Flattening of the articular eminence might occur via alterations from erosion, osteophyte formation,

anterior disc displacement with reduction or anterior disc displacement without reduction. These transformations appear to represent an adaptation of the condyle, articular disc and the articular eminence to changes in loading<sup>2</sup>, and complete edentulousness over a long period of time may lead to several irreversible deformities (like the anatomical changes of the articular eminence of the temporomandibular joint).

According to current literature, several authors give different explanations for the age-related deformation of the temporomandibular joint<sup>3-9</sup>.

Some of them consider the anatomical changes as a result of old age<sup>3-6</sup>, while other studies give

more importance to changes in dental status and function<sup>7-9</sup>.

In the case of infants, the structure of temporomandibular joint is adapted to neonatal edentulousness. In childhood, the eruption of teeth, the formation of occlusion and the growth of the jaws influence and stimulate the development of the temporomandibular joint<sup>10</sup>. Continuous bone remodelling takes place until the joint reaches its adult condition. Throughout the years, the adaptive and regenerative capability of the joint decreases considerably. Being unable to adjust to the elderly change of dental status, finally, it becomes damaged and goes under deformation<sup>7</sup>.

According to the case studies of Helkimo<sup>3</sup> in 1976, some deformation of the masticatory muscles and of the articular surfaces of the joint can be found almost in every patient, but in the elderly population, it occurs more frequently. In 1979, Osterberg and Carlsson<sup>5</sup> found severe joint deformation, clicking and masticatory muscle atrophy in more than half of their patients over the age of 70. Toller and Glynn<sup>6</sup> in 1976 concluded that osteoarthritis of the discotemporal joint was most frequent at an average age of 62.

Some authors noticed that the anatomical changes of the joint were expressed much more in completely edentulous patients<sup>7-9</sup>. According to the findings of Granados<sup>7</sup> in 1979, in complete edentulousness, the angle of sagittal condyle path decreases and so does the height of the articular eminence. Hinton and Raustia<sup>8,9</sup> have observed the flattening of the mandibular fossa and the absorption of the articular eminence. To clarify changes in the trabecular structure caused by loss of the teeth, Kawashima and his team compared soft X-ray images and morphological measurement values of the mandibular condyle and articular eminence between dentate and edentulous human skulls. His conclusion was that at all sites, the density, width, extent and index indicating the complexity of the trabecular bone had higher values in dentate skulls than in edentulous skulls<sup>11</sup>.

There are several methods to determine the angulation of the posterior slope of the articular eminence. Some authors took anthropological measurements carried out on dry skulls<sup>4,5,7</sup>, while others utilised medical imaging techniques<sup>2,11-17</sup>. In several cases, the situation of the investigated points of the temporomandibular joint was determined relative to the Frankfort plane<sup>7</sup>. Clinically, the condylar inclination angle reveals the steepness or the flatness of the posterior slope of the articular eminence and is determined by the intraoral wax record or by extraoral tracing methods<sup>18</sup>. On other

hand, if a panoramic radiographic method is considered, some authors state that the distortions taking place during the imaging of the panoramic X-ray and the over-projection of different anatomical structures on the radiograph do not enable the determination of a completely precise angle on the orthopantomographic image (OPGs)<sup>17,19,20</sup>. At the same time, Gilboa *et al.* recently concluded that the panoramic radiographic image of the sagittal inclination of the articular eminence consistently replicated the eminence inclinations in the 25 human skulls<sup>21</sup>.

The objective of this present investigation was to find out whether there is a connection between the flattening of the posterior slope of the articular eminence and the occlusal status of the patients, and the second goal was to find a possible correlation between the grade of flattening and the age.

## Materials and methods

Thirty patients took part in the investigation and were divided into three different groups each consisting of 10 persons (group I: 18- to 25-year-old patients with maintained occlusion, group II: patients over 60 with maintained occlusion, group III: edentulous patients over 60). The ratio of male to female patients in the examination was 13:17.

Measurements were carried out on OPG taken with a Kodak 8000 Digital Panoramic System (Kodak Dental Systems, Atlanta, GA, USA) in 'Gemisi Dent' Digital Imaging Centre, Budapest, Hungary. The angle between the posterior slope of the articular eminence and the Frankfort plane was measured on the OPG on both sides.

To be able to compare the measured values of patients with different dental status, all radiographs were taken with the same three-dimensional positioning of the patients. Every patient was positioned according to the median sagittal plane, according to the Frankfort plane and according to the plane of the canine with three laser beams and four-point headrests.

To obtain the same positioning for both edentulous patients and patients with maintained occlusion, a noserest was used instead of a tooth-and-chin-support in every case. Employing this method, the radiographs were taken in the physiological resting position of the mandible in all cases. To refine the measurements, a lead calibration ball of 4 mm was placed into the patients' ear.

The angle of the posterior slope of the articular eminence relative to the Frankfort plane was measured on both sides on the OPG radiographic images. To determine the position of the posterior

slope of the articular eminence, the deepest point of the mandibular fossa was connected with the outermost point of the articular eminence relative to the Frankfort plane. Then, the angle between the plotted slope and the Frankfort plane was measured (Fig. 1). The angular measurement was carried out by the KODAK 8000 Digital Imaging Software (Kodak Dental Systems).

Means  $\pm$  the standard deviation (SD) of the angle of the groups were categorised and compared according to dental status, age, sex and side.

Statistical tests were performed with statistical software (SPSS for Windows 11.0; SPSS Inc, Chicago, IL, USA). Associations between variables (mean angles) were analysed with the one-way ANOVA test and the age correlation with linear regression analysis. Results were recorded as mean  $\pm$  SD. All statistical testings were carried out at  $p \leq 0.05$ .

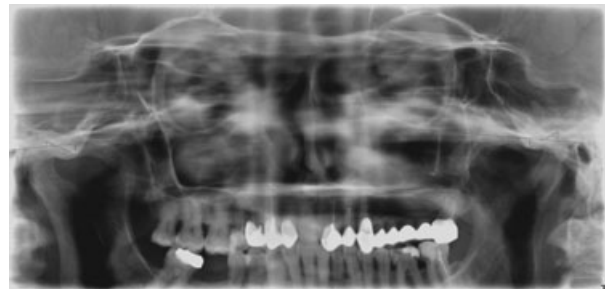
## Results

On the OPG radiographic image of the patients, the Frankfort Plane, the posterior slope of the articular eminence and the angle between them are easily identifiable (Figs 2 and 3). With a completely edentulous patient, the flattening of the articular eminence can be seen with the naked eye (Fig. 4).

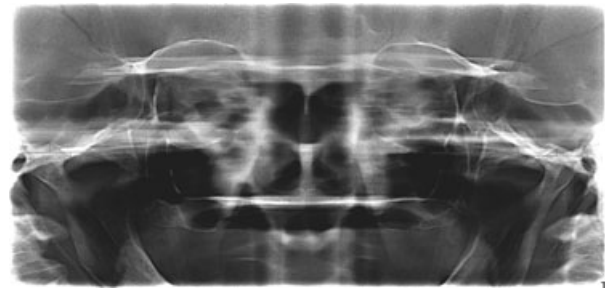
Comparing the mean angle values  $\pm$  SD of the three study groups, the highest values could be detected in group I (right side:  $39.8 \pm 5.4^\circ$ , left side:  $43.0 \pm 5.9^\circ$ , mean:  $41.4 \pm 5.6^\circ$ ), values were not significantly lower in group II (right side:  $38.9 \pm 4.7^\circ$ , left side:  $39.5 \pm 7.4^\circ$ , mean:  $39.2 \pm 6.0^\circ$ ) and were the lowest in group III (right side:  $29.8 \pm 6.0^\circ$ , left side:  $31.9 \pm 5.2^\circ$ , mean:  $30.9 \pm 5.6^\circ$ ;  $p = 0.0013$  compared with the values of group I;  $p = 0.0055$  compared with the values of group II by the ANOVA test). The mean values of the study groups are



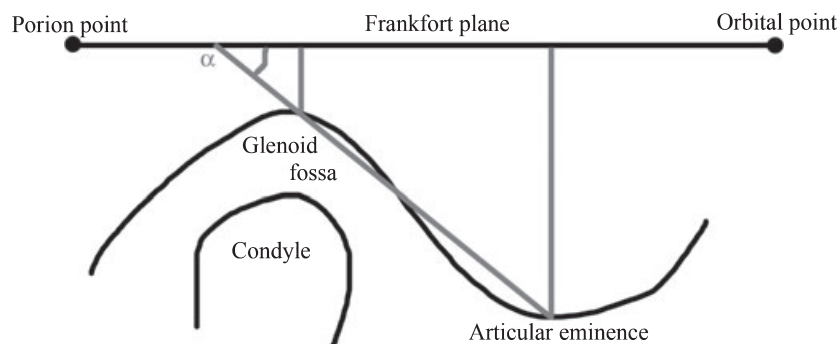
**Figure 2** The orthopantomographic image of a patient from group I.



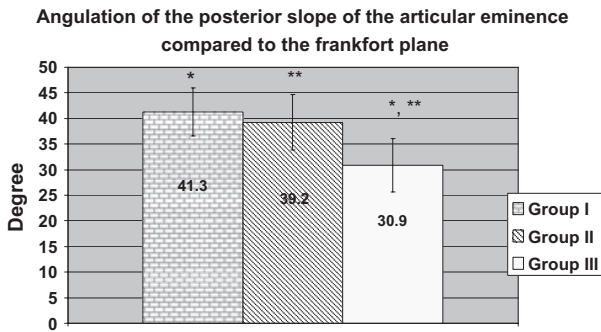
**Figure 3** The orthopantomographic image of a patient from group II.



**Figure 4** The orthopantomographic image of a patient from group III.

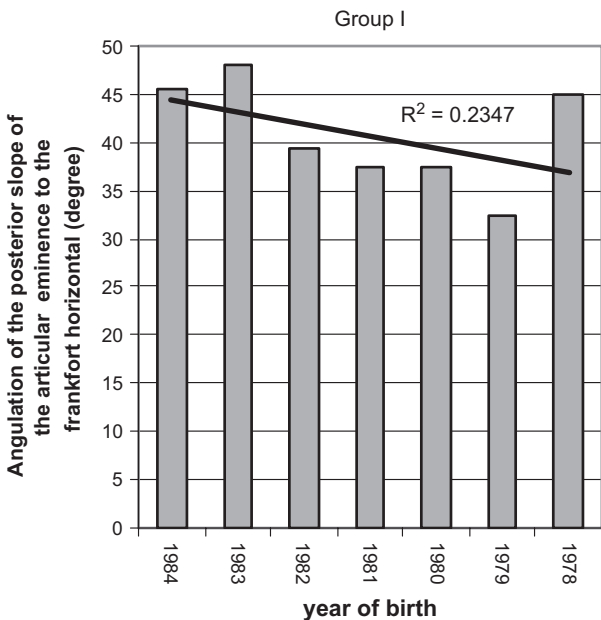


**Figure 1** Sketch of the measurement method: the deepest point of the mandibular fossa was connected with the outermost point of the articular eminence relative to the Frankfort plane. Then, the angle between the plotted slope and the Frankfort plane was measured.



**Figure 5** Comparative analysis of mean angle values of the posterior slope of articular eminence to Frankfort horizontal of the three study groups according to dental status, age, sex and side. \* $p = 0.0013$ , \*\* $p = 0.0055$  by the ANOVA test.

illustrated in Fig. 5. Comparing the differences between the mean angle values of right and left side of the groups, it can be seen that the values found in the group of elderly patients with maintained occlusion were much closer to the values of the young group than to the elderly edentulous group. No significant difference was measured between the right and left side in either of the groups. Neither was there a significant difference between the two genders. The highest values were measured for men in group I and the lowest for women in group III.

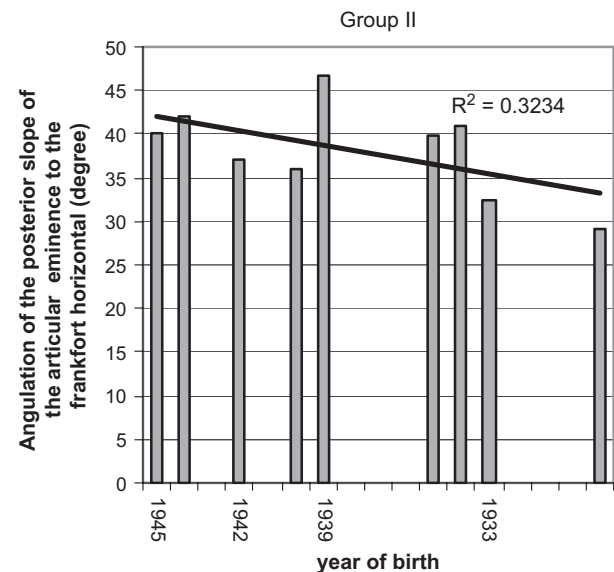


**Figure 6** Linear regression analysis of the posterior slope of the articular eminence within study group I according to the age of the patients.

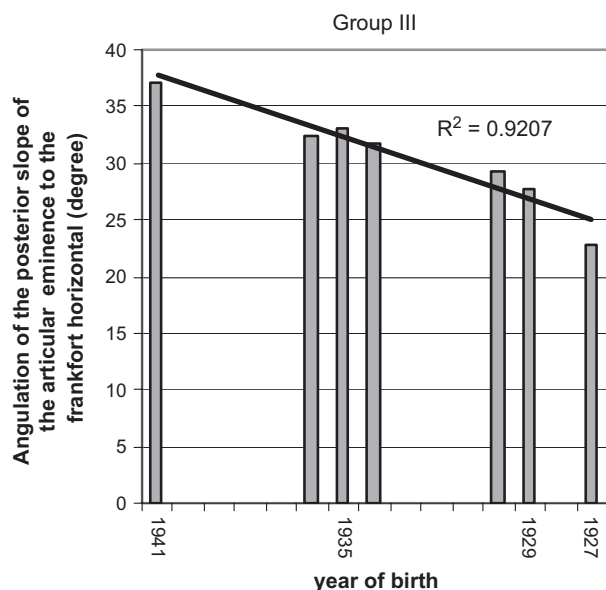
The following investigation was carried out to find out whether there was a measurable correlation between the flattening of the articular eminence and the age of the patients. Angle values of the patients were listed according to age in ascending order, and a linear regression line was plotted on the diagram of each study group. A negative trend could already be seen in group I and became more apparent in group II and group III. The correlation coefficients according to the linear regression analysis were shown to be  $-0.23$  (Fig. 6),  $-0.34$  (Fig. 7) and  $-0.92$  (Fig. 8), respectively.

### Discussion

There was no significant difference between the values of group I and II; however, the angle results of group III differed significantly from both groups I and II. No significant difference was measured between the two sides and between the different genders. Considering the correlation coefficients obtained from the investigation within one study group according to the age of the patients, it seems that the connection between ageing and the flattening of the eminence is present in every group and, however, it is a lot more evident in the old edentulous group. At the same time, the difference in the correlation coefficients between group II and III is significantly higher than between group I and



**Figure 7** Linear regression analysis of the posterior slope of the articular eminence within study group II according to the age of the patients.



**Figure 8** Linear regression analysis of the posterior slope of the articular eminence within study group III according to the age of the patients.

II. This finding leads to the conclusion that tooth loss results in an increased flattening of the posterior slope of the articular eminence than ageing in itself.

In accordance with the results of other studies, the flattening of the posterior slope of the articular eminence is to be considered a result of ageing<sup>3,5,6</sup>; however, it is significantly greater in complete edentulousness than in those with a maintained occlusion. Our data suggest that such a significant difference cannot be explained by the physiological changes in the elderly temporomandibular joint alone. The findings of Granados<sup>7</sup>, Hinton<sup>8</sup> and Raustia<sup>9</sup> also support that changes in dental status influence the structure of the temporomandibular joint. It seems that the longer the patient is edentulous, the higher the rate of the deformation. The maintenance of the intercuspal position and the habitual vertical dimension of occlusion is essential from the viewpoint of the temporomandibular joint. Without a physiological occlusal vertical dimension, an irreversible deformation might occur: the flattening of the articular eminence might cause severe maxillofacial discomfort for the patients and further complications in the prosthetic rehabilitation. The results of this study suggest that it is very important to start the prosthetic rehabilitation of the partially or completely edentulous patients as soon as possible after extractions and restore the physiological occlusion.

## Conclusion

According to the results of this study, the flattening of the articular eminence could be correlated with age; however, the rate of deformation is significantly higher in completely edentulous patients than in patients with a maintained occlusion. It is essential to provide the edentulous patient with early prosthetic and occlusal rehabilitation after extractions to prevent the anatomical changes in the temporomandibular joint.

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