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**ORIGINAL ARTICLE**

# Association of cephalometric changes after 5 years of complete dentures wearing and oral health-related quality-of-life

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**Abstract**

***Objective.*** The aim was to investigate cephalometric changes after 5 years of wearing complete dentures (CDs) and to asses a possible relationship between changes in cephalometric parameters and patients' oral health-related quality-of-life (OHRQoL). ***Materials and methods.*** New complete maxillary and mandibular dentures were fabricated for 30 participants. Two lateral radiographs were obtained from each participant with their CDs in the position of maximal intercuspidation (centric relation): the first radiograph was obtained at the CDs delivery and the second one after 5 years of CDs wearing. A questionnaire (OHIP 14) was given to all participants at the 5-year appointment. ***Results.*** Significant differences in most linear and angular cephalometric measurements were found after 5 years of CDs wearing, due to the reduction of the height of the lower third of the face and the forward shifting of the mandible. A significant correlation between the OHIP summary scores and five cephalometric variables was found (ANS-Xi/Xi-Pm angle, FH/N-Pog angle, SN/Go-Gn angle, Go-Gn/ANS-PNS angle and occlusal plane/FH), indicating that more severe cephalometric changes were related with the increase of OHIP scores. ***Conclusion.*** Changes of cephalometric angles due to lowering of the face and forward shifting of the mandible were related to the decreased OHRQoL (increased OHIP scores).

**Key Words:** *cephalometry, edentulous jaws, OHIP 14, 5-year period*

## Introduction

Although contemporary treatment options for complete edentulousness may include dental implants, conventional complete dentures (CDs) still remain the most common choice of treatment. Oral rehabilitation with conventional CDs plays an important role in restoring facial harmony as well as in oral and general health of edentulous patients. However, residual ridge atrophy (RRR) and related changes during edentulousness affect patients' facial appearance. It is already known that the rate of RRR is ~ 1 mm per year, that it is significantly higher in the first few years after teeth extraction than later and is ~ 4-times higher in the mandible than in the maxilla [1–4]. Alveolar bone loss in the edentulous jaw is a permanent process. The consequences of the RRR are changes in occlusion, counterclockwise rotation of the mandible and a patient's tendency to achieve the Angle Class III [5,6]. In edentulous patients, the loss of alveolar bone eventually leads to a reduction of the vertical dimension of occlusion as well as the rest position of the mandible [7]. The loss of the facial height leads to diminished facial contour and to the typical 'witches profile' and other signs of premature ageing [8].

Edentulousness is a specific condition affecting patient's appearance, speech and ability to chew [1–8] and wearing of CDs can be associated with discomfort, pain and very often a sense of shame which affect the patient's psychological and social life [9–12] and probably the overall quality-of-life. The oral health impact profile (OHIP) is an instrument used to measure subjects' perception of the social impact of oral disorders on their well-being [13].

Complete dentures are usually worn for a remarkably long period of time, although after 5 years nearly 50% of CDs usually need replacement [14]. Nevalainen et al. [15] found that 84% of elderly people wear objectively inadequate and poor dentures which should have been replaced. The CDs wearers

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may be handicapped by poor occlusion, incorrect facial contour or poor speech [16]. While the reduction of a vertical facial height caused by a continuous RRR and changes in sagital maxillomandibular relationship of edentulous patients are reasons for a new prosthodontic treatment need, there is sometimes disagreement between a dentist's and a patient's opinion [14–18]. However, patients may be over-adapted to their inadequate old dentures [12,15,18].

Therefore, the aim was to investigate cephalometric changes after 5 years of wearing CDs and to asses a possible relationship between changes in cephalometric parameters and patients' OHRQoL.

## Materials and methods

Study participants were fully edentulous patients who had visited Department of Prosthodontics of the Dental Clinics in Split, Croatia, with a need of new CDs. A total of 30 participants (13 men and 17 women; mean age of 66 years; age range 56–83 years) were included in the study. Initially, 47 patients (18 male and 29 female) who received their new CDs agreed to take part in the study, but at the follow-up after 5 years of CDs wearing, 16 patients did not respond (11 patients died, two moved away and three had not worn dentures during the observed period). Thus, 31 patients completed the radiographic examination. Written questionnaires (OHIP14-CRO) [19] were given to all remaining patients. One patient had not anwsered some questions of the OHIP14 and was, therefore, excluded from the study.

The Ethics Committee of the Dental Clinics in Split and the School of Medicine, University of Split, approved the study.

New complete maxillary and mandibular dentures were fabricated for all patients at the baseline of the study. All dentures were made following the same criteria (preliminary impressions, individual impressions, semi-adjustable articulator (SAM Präzisionstechnik GmbH, München, Germany), semi-anatomical artificial teeth (25–33° artificial tooth-cusp inclination), lingualized occlusion with no attempt of occlusal balance; during the try-in the occlusal vertical dimension of the dentures was checked by swallowing and speech tests). At the delivery, the occlusion was checked and adjusted when needed and also after 2 weeks of dentures wearing. Retention and stability of dentures were also verified at the dentures delivery and had to be satisfactory for all patients. Two experienced observers assessed 15 sets of CDs for occlusion and retention. The weighted kappa statistics showed satisfactory agreement between the observers ($\kappa = 0.865$). Further assessment was made by one observer. During the 5-year observation period, the dentures have not been relined, but were adjusted in cases of sore spots of the denture bearing area by removing excess material of the denture base.

In order to make the acrylic resin teeth visible on radiographs they were covered with very thin strips of radiopaque material (lead foil cut into small pieces from dental X-ray films (Eastman Kodak, Rochester, NY)). The pieces of foil were bonded (Heliobond, Ivoclar/Vivadent, Schaan, Lichtenstein) and light cured on the vestibular surface of the right upper incisor as close as possible to the midline, ending at the level of the incisal edge of the tooth, on the vestibular surface of the right lower incisor as close as possible to the midline, ending at the level of the incisal edge of the tooth, as well as at the distopalatal cusp of the right maxillary first molar. A lateral cephalogram with thin strips attached to the above-mentioned teeth in order to determine the denture's occlusal plane is shown in Figure 1. The denture's occlusal plane was determined as a plane running from the molar point to the mid-point between edges of the maxillary and mandibular incisors [20].

Two lateral radiographs of each patient were obtained: the first radiograph was obtained at the time of the delivery of CDs, while the second radiograph was obtained 5 years later (mean ± SD = 60 months ± 1 month and 27 days). Lateral

Figure 1. A lateral cephalogram with thin strips of radiopaque material attached on the vestibular surface of the right upper incisor as close as possible to the midline, ending at the level of the incisal edge of the tooth, on the vestibular surface of the right lower incisor as close as possible to the midline, ending at the level of the incisal edge of the tooth, as well as at distopalatal cusp of the right maxillary first molar in order to determine denture's occlusal plane.

cephalograms were obtained with the dentures in the mouth in the position of the centric relation (maximum intercuspidation) during exposure. All radiographs were made using the same equipment (Siemens Roentgen Kugel 2E: 220 V, 15 mA, 70 kV, Munich, Germany; with conventional radiographic film in a 18 × 24 cm cassette) and by the same x-ray technician from the distance of 2 m and exposition varied between 1.2–1.6 s. During the exposure, the head position was fixed in the standard position using a cephalostat.

Cephalometric data was collected from the radiographs by tracing them on an acetate paper with a 3H drawing pencile and a tracing kit (No.075-400-01-Dentaurum, Ispringen, Germany), using a standard light box in a darkened room. All hard tissue landmarks were traced, with bilateral structures averaged to make a single landmark. All linear measurements were performed with a precise calliper (0.1 mm precision, Meba, Zagreb, Croatia) and angular measurements were made with a precise protractor. Angular and linear measurements used in this study are listed in Figure 2 and Table I. All tracings and measurements were performed by the same examiner to optimize landmark identification. However, all tracings of the first radiograph were made immediatly after the radiographs had been obtained. When tracing and measuring the second radiograph, the observer was completly unaware of the results of the previous measurements which had been completed 5 years earlier.

The reliability of the measurements was tested before the first set of measurements had been obtained. A total of 15 baseline radiographs were traced twice within the interval of 1 month between tracings in order to avoid memorization of the anatomical structures. No statistically significant difference was found between measurements for each of the measured variables ($p > 0.05$). The intra-class coefficient of correlation (ICC) varied between 0.96–0.981, depending on the variable. Therefore, it was assumed that the measurements were reliable and the same observer completed all measurements.

After 5 years of CDs wearing patients also received a questionnaire: OHIP14-CRO [19]. Patients had to complete it at home. The questionnaire consisted of 14 questions related to the OHRQoL (Table II). Responses for each item were made on a Likert-type scale: 0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often and 4 = very often (possible scores varied from 0–4 for each item, higher scores indicating more impaired oral health). The OHIP summary score was calculated by summing the scores for each item (maximum possible range was from 0–56).

*Statistical analysis*

Statistical analysis was performed with the SPSS statistical package (version 13, SPSS, Chicago, IL).

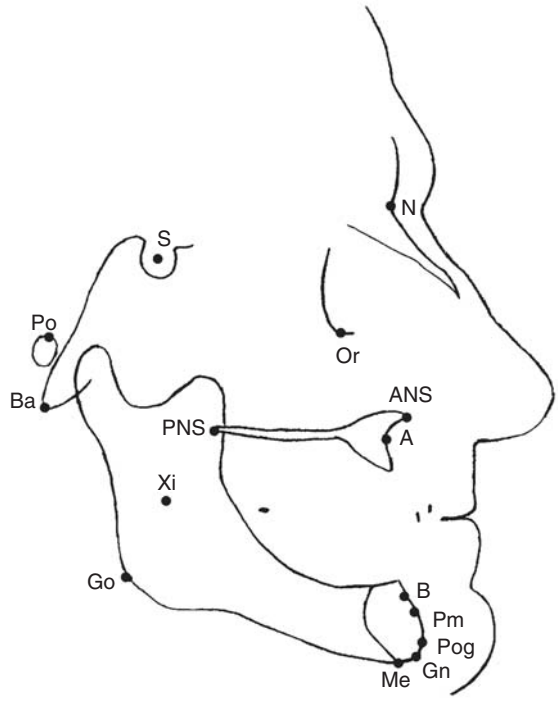


Figure 2. Cephalometric points. N (nasion), the most anterior point of the frontonasal suture in the median plane; S (sella), mid-point of the pituitary fossa (sella turcica); Ba (basion), most inferior posterior point of the occipital bone; Po (porion), the most superior point of external auditory meatus; Or (orbitale), the lowest point in the inferior margin of the orbit; ANS (anterior nasal spine), tip of the bony anterior nasal spine; A (A point), the deepest point of the anterior concavity of the maxilla; PNS (posterior nasal spine), tip of the posterior nasal spine; Xi (Xi point), the geometric center of the ramus of the mandible; Gn (gnathion), the most anteroinferior point on the symphysis of the chin; Pm (suprapogonion), the point where the profile of the mandibular symphysis changes from concave to convex; B (B point), the point at the deepest midline concavity on the mandibular symphysis; Me (menton), the most inferior point on the mandibular symphysis; Pog (pogonion), the most anterior point on the symphysis of the mandible; Go (gonion), the constructed point of intersection of the ramus plane and mandibular plane.

Kolmogorov-Smirnov one sample test was used to test the normality of the distribution. Paired sample *t*-test was used to test the significance of the differences in cephalometric variables between the baseline radiographs and the radiographs obtained after 5-years of CDs wearing. The association between changes of cephalometric variables and the OHIP summary scores was calculated using the Spearman's rank correlation coefficient. The level of significance was set at 95% probability ($p < 0.05$).

## Results

*Changes of cephalometric variables during 5 years of denture wearing*

All cephalometric variables were normally distributed, as assessed by the Kolmogorov-Smirnov one

Table I. Cephalometric measurments.

| Cephalometric measurements | |
|---|---|
| FMA angle (°) | angle formed by the intersection of the FH and mandibular plane |
| ANS –Xi/Xi-Pm angle (°) | angle formed by the intersection of line connecting points ANS and Xi and line connecting points Xi and Pm |
| FH/N-Pog angle (°) | angle formed by the intersection of the FH and the line connecting points N and Pog |
| SN/Go-Gn angle (°) | angle formed by the intersection of the Go-Gn line and line connecting points S and N |
| SN/occlusal plane angle (°) | angle formed by the intersection of the line connecting points S and N and occlusal plane |
| SN/ANS-PNS angle (°) | angle formed between palatal plane and line connecting cephalometric points S and N |
| occlusal plane/ANS-PNS angle (°) | angle formed by the occlusal plane and the palatal plane |
| Go-Gn/occlusal plane angle (°) | angle formed by the Go-Gn line and the occlusal plane |
| Go-Gn/ANS-PNS angle (°) | angle formed by the Go-Gn line and palatal plane |
| occlusal plane/FH angle (°) | angle formed by the occlusal plane and FH |
| FH/ANS-PNS angle (°) | angle formed by FH and palatal plane |
| SNA angle (°) | angle between cephalometric points S, N and A |
| SNB angle (°) | angle between cephalometric points S, N and B |
| Ba-N/N-A angle (°) | angle formed by the intersection of the lines connecting cephalometric points Ba and N and points N and A |
| SNPog angle (°) | angle formed by the intersection of the lines connecting cephalometric points S and N and points N and Pog |
| ANS –Me (mm) | distance between cephalometric points ANS and Me |
| ANB angle (°) | angle between cephalometric points A, N and B |

FH, Frankfort horizontal plane, line that connects orbitale (Or) and porion (P); mandibular plane, line joining the gonion (Go) to the menton (Me) ; palatal plane, line extending between anterior nasal spine (ANS) and posterior nasal spine (PNS); occlusal plane, a plane running from the molar point to the mid-point between edges of the maxillary and mandibular incisors.

sample test ($p > 0.05$). The statistically significant differences were obtained between the first (at delivery of dentures) and the second measurement (after 5 years of denture wearing) for most of the linear and angular cephalometric variables (Table III). The results indicated changes of the facial physiognomy characterized by reducing the anterior lower face height (ANS-Xi/Xi-Pm, SN/Go-Gn, Go-Gn/ANS-PNS, ANS-Me) and changing the position of the mandible, i.e. forward shifting of the mandible (FH/N-Pog, SNPog, SNB, ANB).

*OHIP 14 summary scores*

The mean values of each OHIP item, as well as the mean value of the OHIP-14 CRO summary score are presented in Table II. The OHIP summary score was calculated by summing the scores of each item. The mean value (SD) of the OHIP-14 summary score was 7.36 (5.98).

The mean values of the individual OHIP items ranged from 0.00 (question related to difficulty doing jobs) to 0.83 (item related to trouble of pronouncing words) (Table II). The mean values of each question were not normally distributed ($p < 0.05$); answers were skewed towards lower values for each item. Contrarily, the OHIP summary score showed normal distribution, as assessed by Kolmogorov-Smirnov one sample test ($Z = 1.23$; $p = 0.097$).

*Correlation between cephalometric changes and OHIP14 summary scores*

A significant correlation was found between the OHIP summary scores and five cephalometric variables (ANS-Xi/Xi-Pm angle, FH/N-Pog angle, SN/Go-Gn angle, Go-Gn/ANS-PNS angle and occlusal plane/FH) (Table IV). The correlation between the OHIP summary scores and Go-Gn/occlusal plane almost reached statistical significance ($p = 0.09$). However, the decrease of ANS-Xi/Xi-Pm angle, SN/Go-Gn angle, Go-Gn/ANS-PNS and occlusal plane/FH indicated forward shifting of the mandible and was significantly and negatively correlated with the OHIP summary score, indicating that the decrease of the above-mentioned angles would result in higher OHIP summary scores. However, the decrease of Go-Gn/occlusal plane angle also showed a negative correlation with the OHIP summary score and almost reached statistical significance. The increase of the FH/N-Pog was also measured in the present study as the result of the forward shifting of the mandible. The FH/N-Pog angle was significantly,

Table II. Descriptive statistics for each question of the OHIP 14 together with the OHIP14 summary score.

| Question | Minimum | Maximum | $\chi \pm$ SD |
|---|---|---|---|
| Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.83 ± 0.74 |
| Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures? | 0 | 3 | 1.03 ± 0.89 |
| Have you had painful aching in your mouth? | 0 | 2 | 0.77 ± 0.56 |
| Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth or dentures? | 0 | 2 | 0.67 ± 0.71 |
| Have you been self-conscious because of your teeth, mouth or dentures? | 0 | 2 | 0.23 ± 0.56 |
| Have you felt tense because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.93 ± 0.52 |
| Has your diet been unsatisfactory because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.70 ± 0.70 |
| Have you had to interrupt meals because of problems with your teeth, mouth or dentures? | 0 | 2 | 0.20 ± 0.48 |
| Have you found it difficult to relax because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.33 ± 0.71 |
| Have you been a bit embarrassed because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.73 ± 0.69 |
| Have you been a bit irritable with other people because of problems with your teeth, mouth or dentures? | 0 | 2 | 0.10 ± 0.40 |
| Have you had difficulty doing your usual jobs because of problems with your teeth, mouth or dentures? | 0 | 0 | 0.00 ± 0.00 |
| Have you been totally unable to function because of problems with your teeth, mouth or dentures? | 0 | 1 | 0.07 ± 0.25 |
| Have you felt that life in general was less satisfying because of problems with your teeth, mouth or dentures? | 0 | 3 | 0.77 ± 0.77 |
| OHIP summary score | 2 | 30 | 7.36 ± 5.98 |

but positively correlated with the increase of the OHIP summary score.

## Discussion

The results of the present study showed significant changes of some of the measured angles on lateral cephalographs in CDs wearers through the 5-year period of dentures wearing. The largest and significant changes occurred for those angles that showed the reduction of the lower third of the face (ANS-Xi/Xi-Pm, SN/Go-Gn, Go-Gn/ANS-PNS, ANS-Me). Such changes influenced facial appearance, resulting in lowering of the face height. However, the decrease of the occlusal vertical dimension may also lead to the trauma of the articular fossa associated with pain, discomfort, clicks and headache [21,22].

Our results also demonstrated significant changes of those variables related to the forward movement of the mandible (FH/N-Pog, SNB, ANB, SNPog) through the 5-year period of CDs wearing. The angles ANB and SNPog are used to classify facial types. An ANB angle greater than 1.5° is associated with the Class II skeletal pattern and an ANB angle of 0° or less indicates a tendency to the Class III skeletal pattern [23]. In the study by Tuncay et al. [23] the pogonion moved forward significantly, increasing the SNPog angle and decreasing the ANB angle, resulting in the pseudo Class III appearance. However, the pseudo Class III appearance can again become Class I when the occlusal vertical dimension is increased by a set of new dentures, resulting in a better facial apperance [24].

Our results support the studies showing that residual ridge atrophy and wear of acrylic resin teeth and denture movement on the underlying tissue lead to changes of some cephalometric angles and planes [1–4]. Consequently, we found significant changes in relation between the occlusal plane and some other cephalometric planes (SN/occlusal plane, occlusal plane/FH, occlusal plane/ANS-PNS). The occlusal plane probably moved together with the mandible, which resulted in changing of the relationship with viscerocranium planes, while the proportion of the occlusal plane and the base of the mandible during the 5 years did not change significantly. A correct relationship of occlusal plane in patients' mouth prevents the masticatory forces from acting at right angles to the basal seat and helps to stabilize the denture [25].

The observed changes of mandibular/maxillary relation can lead to a decrease of patients' satisfaction with their complete dentures and their facial appearence. In previous studies, patient's satisfaction with prosthetic rehabilitation was compared with the professional opinion of the dentist, which can also be subjective [26–28]. Van Waas reported poor agreement among three experienced prosthodontists regarding the assessment of the quality of new dentures [29].

Table III. Changes of cephalometric variables after 5 years of denture wearing.

| Parameter | First measurement ($\chi \pm$ SD) | After 5 years ($\chi \pm$ SD) | $p^{\dagger}$ |
|---|---|---|---|
| FMA | 20.85 ± 6.36 | 20.47 ± 6.21 | 0.597 NS |
| ANS-Xi/Xi-Pm | 48.11 ± 3.23 | 46.01 ± 3.15 | < 0.001** |
| FH/N-Pog | 88.43 ± 3.43 | 89.71 ± 3.39 | < 0.001** |
| SN/Go-Gn | 31.38 ± 3.76 | 30.46 ± 3.85 | < 0.001** |
| SN/occlusal plane | 12.96 ± 2.71 | 12.81 ± 2.62 | < 0.001** |
| SN/ANS-PNS | 8.55 ± 3.19 | 8.39 ± 3.19 | 0.026* |
| occlusal plane/ANS-PNS | 6.38 ± 2.86 | 6.21 ± 3.05 | 0.009** |
| Go-Gn/occlusal plane | 16.88 ± 3.83 | 16.68 ± 6.21 | 0.80 NS |
| Go-Gn/ANS-PNS | 20.95 ± 6.24 | 19.78 ± 5.68 | < 0.001** |
| occlusal plane/FH | 10.26 ± 1.65 | 9.65 ± 1.31 | < 0.001** |
| FH/ANS-PNS | 2.75 ± 1.41 | 2.71 ± 1.39 | 0.184 NS |
| SNA | 81.96 ± 3.33 | 82.03 ± 3.35 | 0.475 NS |
| SNB | 79.21 ± 2.36 | 80.43 ± 2.32 | < 0.001** |
| Ba-N/N-A | 61.58 ± 4.92 | 61.71 ± 5.01 | 0.487 NS |
| SNPog | 81.06 ± 2.53 | 82.15 ± 2.44 | < 0.001** |
| ANS-Me | 7.29 ± 0.66 | 7.11 ± 0.68 | < 0.001** |
| ANB | 0.91 ± 1.87 | 0.38 ± 1.61 | < 0.001** |

†Paired samples *t*-test, **$p < 0.01$; *$p < 0.05$; NS, not significant, $p > 0.05$.

We compared a level of the OHRQoL after 5 years of CDs wearing with the cephalometric changes that occured during the same period. The responses of the OHIP14-CRO items obtained in this study ranged from 0–3 (maximum possible was from 0–4) and the OHIP summary score ranged from 2–30 (maximum possible range was from 0–56), depending on the patient. The responses given in the questionnaire were mainly tending towards lower scores, indicating that the majority of patients had no major objections regarding their CDs, although they were 5 years old. Fenlon and Sherriff [30] showed that denture quality was a significant predictor of denture wearing and patient's satisfaction only in the first 3 months after insertion, but patients who were able to become habituated to wearing dentures over an initial (3 month) period, denture quality thereafter had no significant effect on patient's satisfaction. In a study conducted by Nevalainen et al. [15], 69% of patients assessed their dentures as good or satisfactory, whereas when objective evaluation by dentists was done, 84% of the dentures were assessed as inadequate.

The facts that the patients' responses in this study were mainly 0 and 1, and that the average OHIP summary score was only 7.5 did not mean that the CDs were good and without a need for the replacement. The results obtained for the OHIP score in this study are consistent with the results from other studies demonstrating that patients were often satisfied with their 5-year-old CDs and were over-adapted to them [15]. There is a perception, particularly in relation to older people, that the replacement of CDs can result in problems of adaptation, which lead to difficulty in learning how to use the new appliances [31,32]. Most edentulous patients feel helpless and believe that they have to accept denture problems as a part of the fact related to wearing a prosthesis [33]. Yet, it has been shown that both satisfied and dissatisfied patients benefitted after poorly fitted dentures had been relined or

Table IV. Correlation between OHIP—summary score and changes of cephalometric variables.

| | Cephalometric variables | | | | | |
|---|---|---|---|---|---|---|
| OHIP summary score | ANS-Xi/Xi-Pm | FH/N-Pog | SN/Go-Gn | Go-Gn/occlusal plane | Go-Gn/ANS-PNS | occlusal plane/FH |
| Spearman's Correlation ($r$) | −0.53** | 0.60** | −0.419* | −0.317 | −0.598** | −0.429* |
| Significance | 0.003 | < 0.001 | 0.021 | 0.09 NS | < 0.001 | 0.018 |

**$p < 0.01$; *$p < 0.05$; NS, not significant, $p > 0.05$.

replaced with new dentures [34]. However, Berg [35] suggested that the overall satisfaction with CDs was mainly a reflection of patients' opinion regarding the mandibular denture, with a remark that patients' satisfaction with dentures is probably multifactorial.

Although the distribution of both cephalometric variables and the OHIP14-CRO summary score obtained in this study was normal, it was decided to test the correlation between them by the Spearman's rank correlation coefficient rather than Pearson's correlation, as the sample of patients in this study was rather small and the distribution of the OHIP summary score showed a tendency towards lower values. Findings of the present study demonstrated that changes of the mandibular position through the 5-year period of CDs wearing might affect patient's OHRQoL. We detected a significant negative correlation between the decrease of the lower third of the face with consequent forward movement of the mandible and an increase of the OHIP summary score. Changes of the cephalometric angles led to changes of the perioral soft tissue, older appearence and patient's tendency towards Angle Class III with consequent jaw relation changes. Vertical height was reduced, the mandible moved forward and upward together with the denture's occlusal plane. Consequently, the naso-labial folds developed, fine vertical rhytids appeared and lips appeared thin with the loss of exposed vermillion. There was also diminished tooth display of the maxillary anterior teeth and an increased display of the mandibular anterior teeth. The corners of the lips tended to droop downwards and to join up with the marionette folds [8].

Significant correlation beetwen changes of cephalometric angles through a 5-year period of CDs wearing and the OHIP summary scores might be due to deteriorated facial aesthetics. Changed jaw relations decreased the OHRQoL.

However, the OHIP14 summary score includes several dimensions, such as functional, psychological and social impact of functional and aesthetic factors on a patient's well-being and the quality-of-life. It is not easy to distinguish a degree of possible functional and/or aesthetical impact on the OHRQoL and the specific relation with the changes of certain cephalometric variables and it will be the subject of further study.

***Declaration of interest:*** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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