DPJO
Dental Press Journal of Orthodontics

Volume 27 - Number 6 - Online

SPECIAL ARTICLE

https://doi.org/10.1590/2177-6709.27.6.e22spe6

Normal occlusion in maturational life process

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Submitted: November 07, 2022 • **Revised and accepted:** December 05, 2022

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How to cite: Garib D, Miranda F, Massaro C. Normal occlusion in maturational life process. Dental Press J Orthod. 2022;27(6):e22spe6.

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ABSTRACT

Introduction: An increase in life expectancy was observed in the past years. Consequently, the knowledge of the maturational changes in the occlusion is highly important to guide clinicians during treatment planning.

Objective: In this article, the occlusal and facial aging changes occurred during almost 50 years of follow-up are described. A normal occlusion sample from Bauru Dental School, University of São Paulo, Brazil, was evaluated at 13 (T1), 17 (T2) and 60 (T3) years of age. The maturational changes observed in digital dental models and cephalometric radiographs were presented. A revision of the aging process, under the gerontology and psychology perspectives, was also explored.

Discussion: Maturational changes in non-treated individuals were very delicate. Mandibular crowding, decrease in the overbite, changes in the maxillary second molar position, increase in the clinical crown length, dental wear and discoloration were observed.

Conclusion: Compared to the remarkable facial and skin changes during aging, the occlusion seems to be the most stable feature of the face during the aging process.

Final considerations: An adequate oral care throughout lifetime makes the smile the best memory of youth at mature ages.

Keywords: Aging. Dental occlusion. Orthodontics.

RESUMO

Introdução: Nos últimos anos, observou-se um aumento considerável na expectativa de vida. Consequentemente, o conhecimento das alterações na oclusão com o envelhecimento é de extrema importância para orientar os cirurgiões-dentistas e ortodontistas durante o planejamento do tratamento.

Objetivo: Neste artigo, serão apresentadas as alterações maturacionais da oclusão e da face observadas durante um acompanhamento de quase 50 anos. Uma amostra com oclusão normal da Faculdade de Odontologia de Bauru da Universidade de São Paulo foi avaliada aos 13 (T1), 17 (T2) e 60 (T3) anos de idade. As alterações maturacionais observadas nos modelos de estudo e telerradiografias serão apresentadas, após uma breve revisão sobre o processo de envelhecimento, sob as perspectivas da Gerontologia e da Psicologia.

Discussão: As alterações oclusais com o envelhecimento nesses indivíduos não tratados foram discretas, observando-se: suave apinhamento dos incisivos inferiores, diminuição da sobremordida, mudanças na posição do segundo molar superior, aumento na altura da coroa clínica, desgaste e alteração de cor dos dentes.

Conclusão: Em comparação às notáveis mudanças da face e da pele durante o envelhecimento, a oclusão parece ser a parte mais estável da face durante o processo de envelhecimento.

Considerações Finais: Um adequado cuidado da saúde bucal ao longo da vida pode fazer do sorriso, em idades mais maduras, a melhor lembrança da juventude.

Palavras-chave: Envelhecimento. Oclusão dentária. Ortodontia.

INTRODUCTION

An important increase in life expectancy was observed in the past few years.[1] Back in Angle's time, life expectancy was around 40 years of age. In the present days, many men and women reach 70-80 years, living well in professional activities without health problems. Over 900 million people are now over 60, and this number is expected to double by 2050. The extensive and detailed knowledge of occlusal aging is helpful in guiding the dental professional for anti-age procedures. Clinicians should be aware of aging changes, in order to avoid producing alterations that can be naturally achieved.

The skeletal and dentoalveolar maturational changes of normal occlusion subjects were reported until the sixth decade of life.[2-4] The classic growth study of Behrents showed continued and decreasing craniofacial growth changes in adulthood.[2,3] During aging, the soft tissue changes were more remarkable than the skeletal changes. A forward and downward mandibular displacement in men and backward mandibular rotation in women were reported.[2,3] The craniofacial growth showed a decelerating pattern throughout adulthood, with a minimal rate after the 40 years of age.[2,3]

The dentoalveolar maturational changes were also evaluated during adulthood.[4-13] Untreated subjects demonstrated a decrease in arch size and an increase in dental crowding after adolescence.[4,5,8,10,11,13] The maturational changes found for overbite varied between increase, stability and decrease.[5,8,10,12] On the other hand, most studies reported a stability of the overjet during adulthood.[5,13-15]

A normal occlusion sample comprising 82 White-Brazilians was collected at Bauru Dental School, University of São Paulo, Brazil in the sixties and seventies. Dental models and cephalometric radiographs were taken at the ages of 13 (T1) and 17 (T2). From 2015 to 2016, the subjects were recalled at the age of 60 (T3). Twenty-two patients were recorded at T3. Occlusal and facial aging changes occurred during the 50 years follow-up. As part of the present research, these changes will be described in the next topics. However, it is necessary to first present a preview of the aging process, under the gerontology and psychology perspectives.

AGING: GERONTOLOGICAL ASPECTS

Life expectancy increase over this century had an important impact on public health. An influence of these changes in Dentistry and oral health is also expected. Therefore, we should accompany these modifications, trying to understand their impact on the quality of life and treatment expectations of mature patients.

People are living longer. This means we are having additional years to live in the best possible manner. The global life expectancy at birth increased from 66 to 73 years from 2000 to 2019.[1] According to the World Health Organization data from 2019, Europe showed the highest estimate (78 years).[1] In the same year, the countries with greatest life expectancy were Japan, Switzerland, South Korea, Singapore, and Spain.[1] In Brazil, life expectancy increased from 68 to 76 years from 2000 to 2020.[16] In other words, in 2000, a 60-year-old Brazilian could expect to have on average 8 further years of life. Twenty years later, in 2020, this estimate is almost twice greater, and, at 60 years old, we may expect to have additional 16 years of life. Additionally, women are expected to live longer than men all over the world.[1,16] In 2019, global life expectancy was 70 years for males and 75 years for females.[1] In Brazil, the data from 2020 shows that life expectancy was 80 and 73 years for women and men, respectively.[16]

The way each person goes through the aging process as well as the length of the elderly phase is unique, and will depend on genetic, environmental and behavior factors. In addition to the follow-up of the life expectancy, studies have also reported an increase in the number of years a person can expect to live in "full health".[1,17,18] From 2000 to 2019, the number of years to be lived with health increased from 58 to 63 years in the world.[1] Data from the World Health Organization showed

that, in 2019, "healthy life expectancy" was approximately 10 years smaller than the general life expectancy for most countries on earth.[1] In the same year, Japan, Singapore and South Korea were the countries with the greatest healthy life expectancy in the world (74.1, 73.6, and 73.1 years, respectively).[1] Considering the disability-free life expectancy, the life expectancy in good perceived health and the life expectancy without chronic morbidity, a previous study suggested a significant increase in healthy life expectancy in practically all age groups in Brazil from 1998 and 2008.[17] So, we may expect to live further years with health during elderly.

During aging, tooth decay and erosion, periodontal disease and tooth loss are common oral health problems. In the United States, 19% of adults aged 65 and over were edentulous in 2011-2012.[19] Maturational changes of the face and smile can also affect the wellbeing. The complete physical, mental, and social wellbeing is not a direct result of the presence or absence of a disease, regardless of the age. During elderly, the quality of life and self-esteem is becoming increasingly important. The maintenance of personal autonomy and happiness as well as to keep integrated into the society are some targets to make aging healthier. In this scenario, aging of the face, occlusion and dentition is an important topic to be considered to provide the best treatment and counseling for mature patients in different areas of Dentistry.

AGING: PSYCHOLOGICAL ASPECTS

The aging process is complex and involves not only biological aspects, but also psychological aspects. The psychological aspects of aging are individually determined, and may depend on the concept of subjective aging.[20] The subjective aging is related to the way subjects perceived their own aging process.[20] Individual and sociocultural factors may influence the subjective aging and the aging process itself.[20] A previous meta-analysis found a small but significant effect of subjective aging on health, health behaviors and survival over time.[21] Following these findings, a greater importance should be given to aging and communication, in a social and individual aspect.[20,21] A previous study assessed the age identity of a sample of 666 participants with an age range of 51-92 years.[22] The mean chronological age of the sample was 70 years; however, their mean subjective age was 62 years. In addition, the sample presented a mean of 63 years for how other people would perceive their age. A strong correlation was found between their subjective age and the age they think other people think they are.[22]

Psychological health during aging can be affected by stereotypical beliefs created during life about older persons.[23] In a sample of 433 participants with a mean age of 61.7 years, the impacts of positive and negative self-perceptions of aging on the functional health over time was analyzed.[23] The sample was assessed six times during a 18-year period. The participants with more positive self-perceptions of aging showed better functional health over time, when compared to the participants with negative self-perceptions of aging.[23] In a similar study, the association between positive and negative age stereotypes in the recovery from disabilities was analyzed.[24] The sample consisted of 598 participants with a mean initial age of 79 years. The group with positive stereotypes showed 44% more likelihood to fully recover from severe disability than the group with negative stereotypes.[24]

Emotional control is often diminished with aging. In addition, an increase in anxiety and fear can occur with the aging process.[25] The aging anxiety can become pathological if disproportionate from reality. Negative events such as declining health, loss of capabilities, chronic diseases, depression and

functional limitations may impair the mental health of mature individuals. Social support, coping mechanisms, positive attitudes and self-efficacy have a positive effect on maintaining an adequate mental health during aging.[26-29]

The psychological aspect and mental functioning can be affected by aging.[1] However, as shown above, psychological health may be influenced on an individual basis. When considering aging as public-health, the reinforcement of recovery, adaptation and psychosocial growth is essential.[1]

FACIAL CHANGES WITH AGING

The science has not been capable of interrupting facial aging changes. Dermatological treatment and cosmetic procedures can attenuate natural maturational alterations. However, no plastic surgery can yet transform a senescent face into a natural youthful face.

The face of a young adult displays a harmonious skin texture and smooth facial contours. Due to intrinsic (genetics, ethnicity, cell turnover changes, dermis structural changes) and extrinsic factors (sun exposure, smoking), remarkable skin changes are observed with aging, including the skin laxity, dynamic and static wrinkles, and increase of pigmentations (Figs 1 and 2).

Skin thins and weakens as the dermis atrophies. Volume displacement toward inferior and medial is observed with gravity. The aging of the face is not only related to skin changes, but also facial bone remodeling, and fat pads atrophy. The aging process involves all the layers of the facial anatomy.[30]

In the forehead, multiple long transversal wrinkles appear, together with vertical wrinkles at the base of the nose. A flattening of the forehead occurs with aging, contributing to the dropping of the browns and eyelids medially. The temple region, where the temporalis muscle is located, flattens, creating a shadow laterally to the eyes and a gaunt appearance.

The periocular area is a focal point of the face, and changes remarkably with aging. The browns have a decrease in the anterior projection and descent toward inferior. The upper eyelids move downward and the infraorbital rim depression increases. The eyelids aperture become smaller.[31] Lateral periorbital wrinkles appear. Bony recession of the orbital rim causes the enlargement of the orbit aperture.

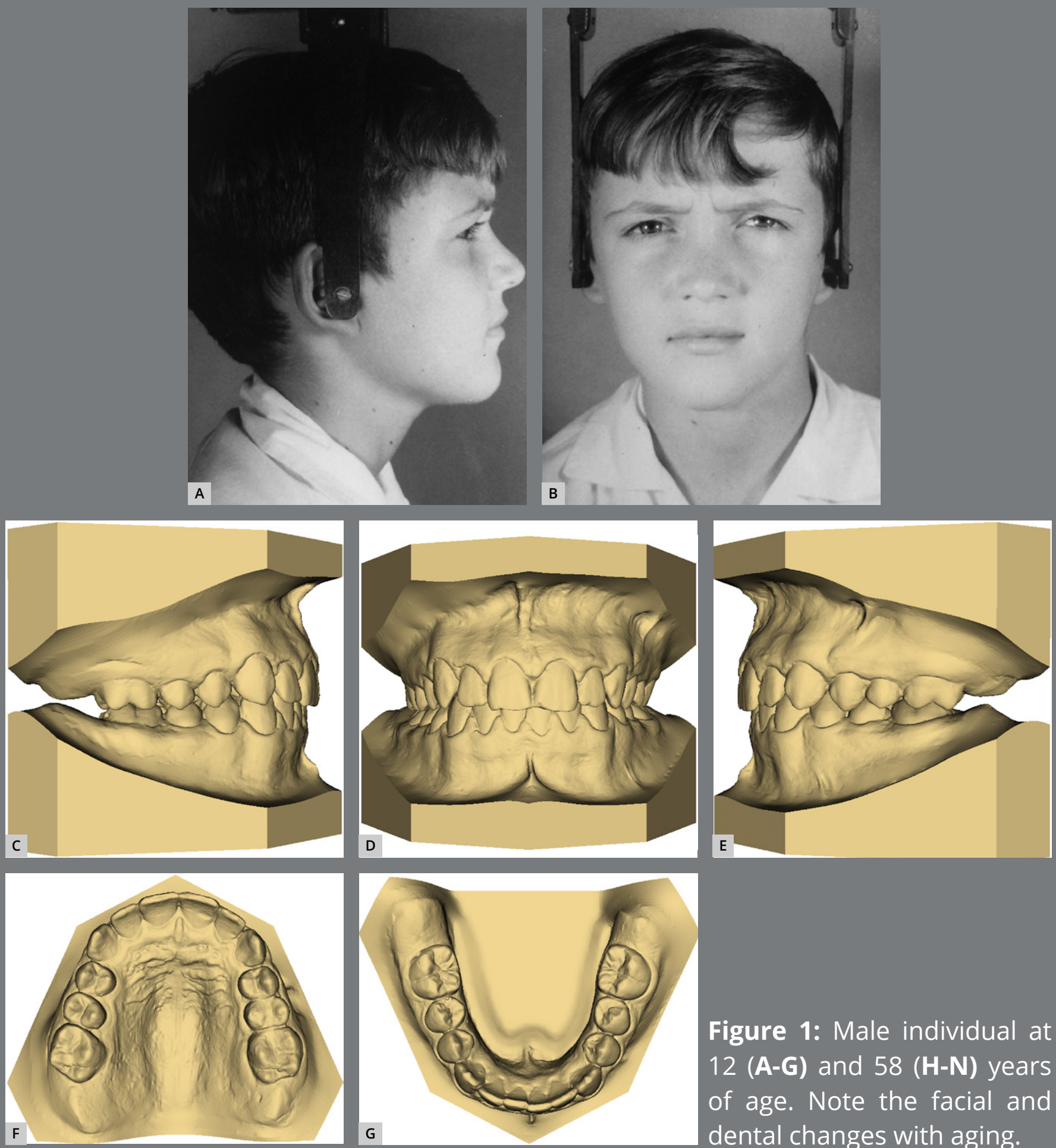


Figure 1: Male individual at 12 (**A-G)** and 58 (**H-N)** years of age. Note the facial and dental changes with aging.

Figure 1 (continuation): Male individual at 12 (**A-G)** and 58 (**H-N)** years of age. Note the facial and dental changes with aging.

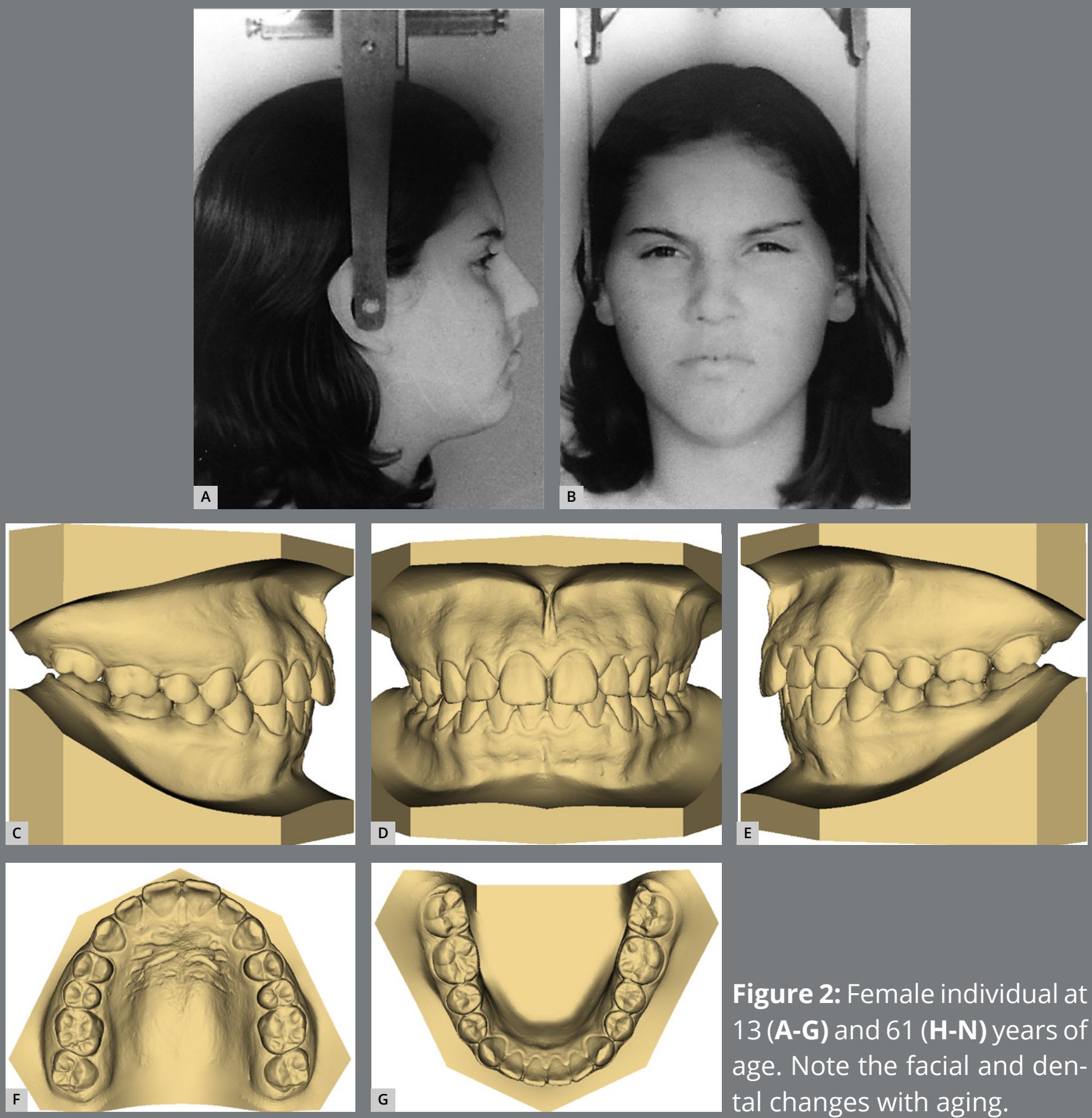


Figure 2: Female individual at 13 (**A-G)** and 61 (**H-N)** years of age. Note the facial and dental changes with aging.

Figure 2 (continuation): Female individual at 13 (**A-G)** and 61 (**H-N)** years of age. Note the facial and dental changes with aging.

The midface and malar prominence lose volume with aging, not only due to fat and muscle changes, but also due to the bone remodeling and bone resorption of the maxillary surface. The malar fat descends and the cheeks display a double convexity, with a loss of the Ogee curve.[32] The nasolabial fold appears. The recession of the surrounding supporting structures of the nose causes a retraction of the columella and an inferior displacement of the nose tip (Fig 1). The nasal alae retrusion into the cheek is observed, with an alar base widening.

In the perioral region, a flattening of the upper lip occurs, caused by a thinning of the perioral skin and orbicularis oris muscle. Consequently, the upper lip elongates, straightens and loses concavity. The amount of upper lip vermillion decreases (Figs 1 and 2). With timing, radial wrinkles appear in the upper lip. Changes in the lower lip are lesser, compared to the upper lip. A labiomandibular fold appears laterally to the lower lip, extending into the chin, known as “marionette lines”. Jawline losses definition and develops ptotic jowling.[30] The chin-neck line becomes convex and flaccid.

CEPHALOMETRIC CHANGES IN MATURE ADULTS

During adulthood, skeletal and soft tissue changes occur, and can be observed using cephalometric analysis. From 17 to 60 years of age,[33] the anterior cranial base, maxilla and mandible showed an anteroposterior increase of approximately 3, 5 and 6 mm, respectively. The maxillary and mandibular protrusion slightly increased in man. Vertical changes are also very clear from early to late adulthood. Both anterior and posterior facial height increased by 3 mm. In the vertical plane, a sexual difference was observed,[33] confirming the findings of the classical study by Behrents in non-treated individuals.[2,3] Men presented a counterclockwise rotation of the mandible (Fig 3). Conversely, women showed a clockwise rotation of the mandible (Fig 4). Men showed a significantly greater increase of the mandibular ramus height during adulthood than women, which explain the vertical differences between sexes. Teeth continue to erupt over time during adulthood. The maxillary and mandibular molars extruded simultaneously to the facial vertical growth. In this regard, the molar extrusion is greater in the maxilla (3 mm), compared to the mandible (1 mm).

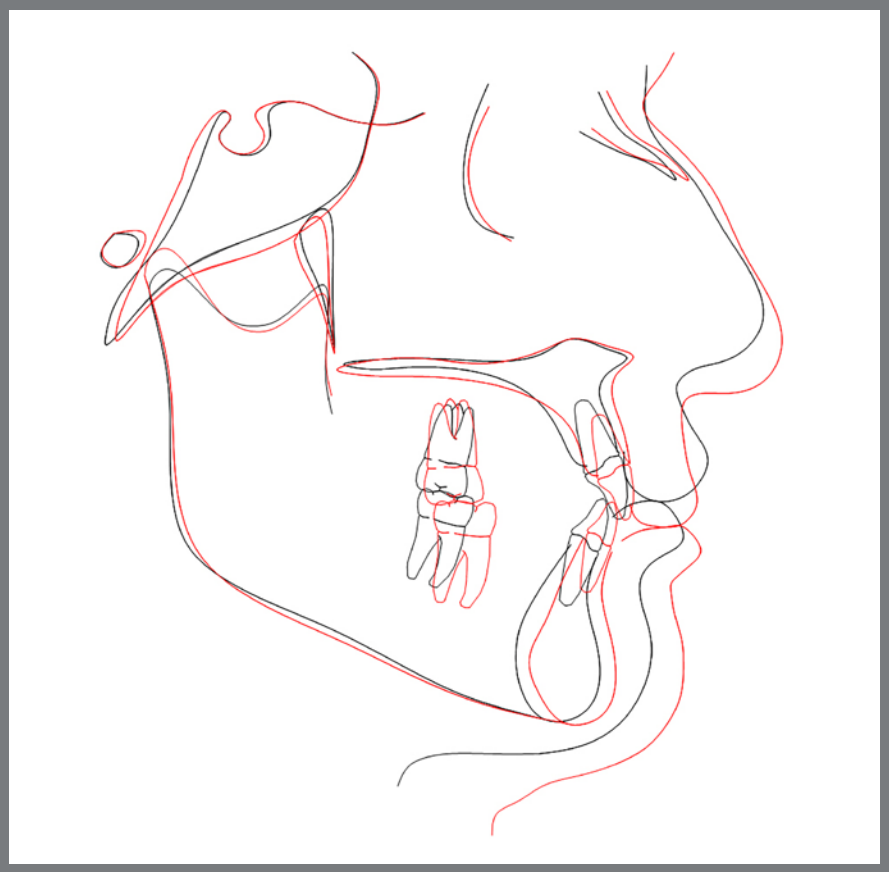


Figure 3: Cephalometric tracing of a male individual at 14 (black lines) and 63 years of age (red lines).

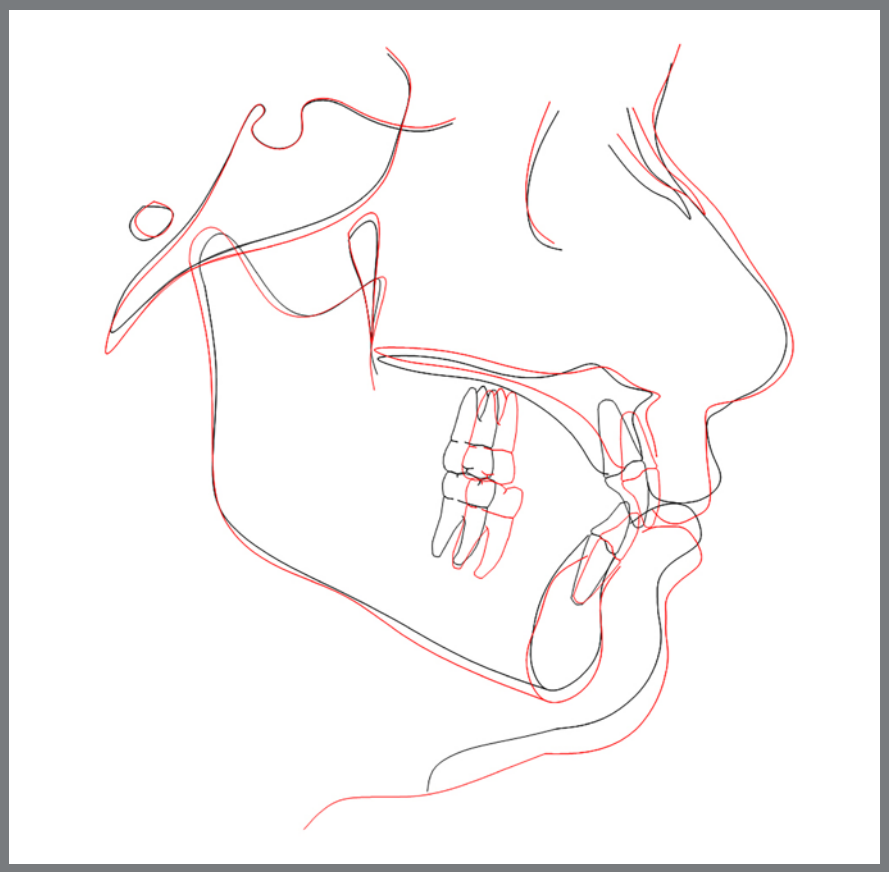


Figure 4: Cephalometric tracing of a female individual at 12 (black lines) and 59 years (red lines) of age.

The soft tissue changes at the lip and nasal region changed strikingly during aging.[33] A clinically relevant retrusion of the upper and lower lips was noted. The retrusion of the upper lip (3.5 mm) was greater than that observed in the lower lip (2 mm) over 40 years of maturation. The retrusion of the lips was related to two maturational changes: 1- An actual decrease of the upper lip thickness; and 2- A relative lip retrusion, due to the forward movement of the nose and chin during aging. Surprisingly, lip retrusion was not associated with changes in

the upper and lower incisor protrusion with aging. A stability in the sagittal position of both the maxillary and mandibular incisors was observed from late to mature adulthood. Aging changes in the nose included not only a forward displacement, but also a downward movement of the nose tip, closing the nasolabial angle by 6 degrees. It is important to highlight that lip retrusion, and nose and chin forward displacement during aging were greater in male, compared to female. Soft-tissue chin thickness increased throughout life.

Another soft tissue change that is significant during aging is the reduction of the maxillary incisor display by the upper lip. Exposure of the maxillary incisor decreased by 4 mm within 40 years both in men and women. In other words, a 1 mm-decrease in the maxillary incisor display every decade can be expected during aging.

AGING OF THE DENTITION

TOOTH WEAR

Erosive tooth wear (ETW) is the cumulative loss of dental hard tissue due to chemical-mechanical processes.[34,35] ETW presents a multifactorial etiology and it is described as the loss of the natural surface morphology and contour.[34,36] ETW progression

assessment is important, once the progress of ETW is continuous over lifetime.[34] As the severity of ETW increases, it becomes easier to distinguish between pathological and physiological loss of tooth tissues.[34]

The prevalence of ETW was extensively studied in the past, and showed a varying percentage from 9% at 12 years of age to almost 26% at 46-50 years of age.[37,38] However, few studies have evaluated the longitudinal pattern of ETW. In a previous study, a sample of 55 randomly selected individuals was followed during a 6-year period, to investigate the longitudinal effects of ETW.[38] The sample was split into two age groups: a younger age group (26-30 years of age), and an older age group (46-50 years of age). An increase in ETW was observed after 6 years of follow-up.[38] In addition, the older age group showed more marked ETW defects than the younger age group.[38] Therefore, age may play an important role in the progression of ETW.

Recently, a longitudinal analysis of ETW was conducted in a sample of 23 Brazilian individuals with normal occlusion with a 47-year follow-up. The sample was analyzed at 13, 17 and 60 years of age. Digital dental models were assessed using the BEWE index,[39] which scores the ETW from 0 (no surface loss) to 3 (more than 50% of the surface area loss).

A significant increase was found for ETW during aging in all time-points evaluated. Males demonstrated a greater level of ETW, when compared to females. Incisors and canines were the most affected teeth. These results are in accordance with previous studies that found an increased BEWE index with age.[40-42] In addition, it can be speculated that the sexual dimorphism observed in the ETW can be related with the greater muscular strength, differences in biting forces, food preferences and type of behavior/lifestyle. Figure 5 shows a male individual at 58 years of age, with a moderate level of tooth wear.

Figure 5: Intraoral photographs of the same patient presented in Figure 1. A moderate level of tooth wear can be observed.

TOOTH COLORING

Changes in tooth color are expected with aging, and can be caused by both intrinsic and extrinsic factors. A previous study evaluated the changes in tooth coloring in a sample of 1361 Caucasian individuals, with ages varying from 16 to 89 years.[43] When comparing the sample regarding age, there was a tendency for teeth to become darker, yellower and more reddish. In addition, male tended to show darker and yellower teeth than female with aging.[43]

Similarly, in a sample of 405 Chinese individuals with ages from 13 to 64 years, teeth also became darker and yellower with aging.[44] The sample was questioned in relation to the self-satisfaction related with tooth color, and 52,6% reported a negative evaluation. A correlation between the decrease in self-satisfaction with tooth color and the increase on the severity of discoloration with aging was found.[44] In the present sample of Brazilian individuals with normal occlusal, changes in tooth coloring were one of the chief complaints at 60 years of age.[9]

PERIODONTAL CHANGES

Periodontal disease is a common oral problem that affects approximately 10.8% of the worldwide population.[45] Periodontitis is cumulative and multifactorial, and its severity may increase

with aging. A previous study showed that aging is associated with a moderate loss of periodontal attachment and alveolar bone loss. However, these changes did not lead to greater loss of periodontal support in health adults.[46] A previous review concluded that age increases the risk for periodontal disease, but the aging process alone is not the main cause to accelerate the bone loss.[47]

A previous study analyzed the alveolar bone loss in a mixed population of 229 individuals with an age ranging from 20 to 84 years.[48] Individuals with a good oral hygiene showed a bone loss rate of 0.38 mm per decade. Conversely, in the presence of poor oral hygiene, a bone loss rate of 0.89 mm per decade was observed.[48] A progressive and rapid increase in bone loss rate was observed from 30 to 50 years, followed by a leveling in this rate after 60 years of age.

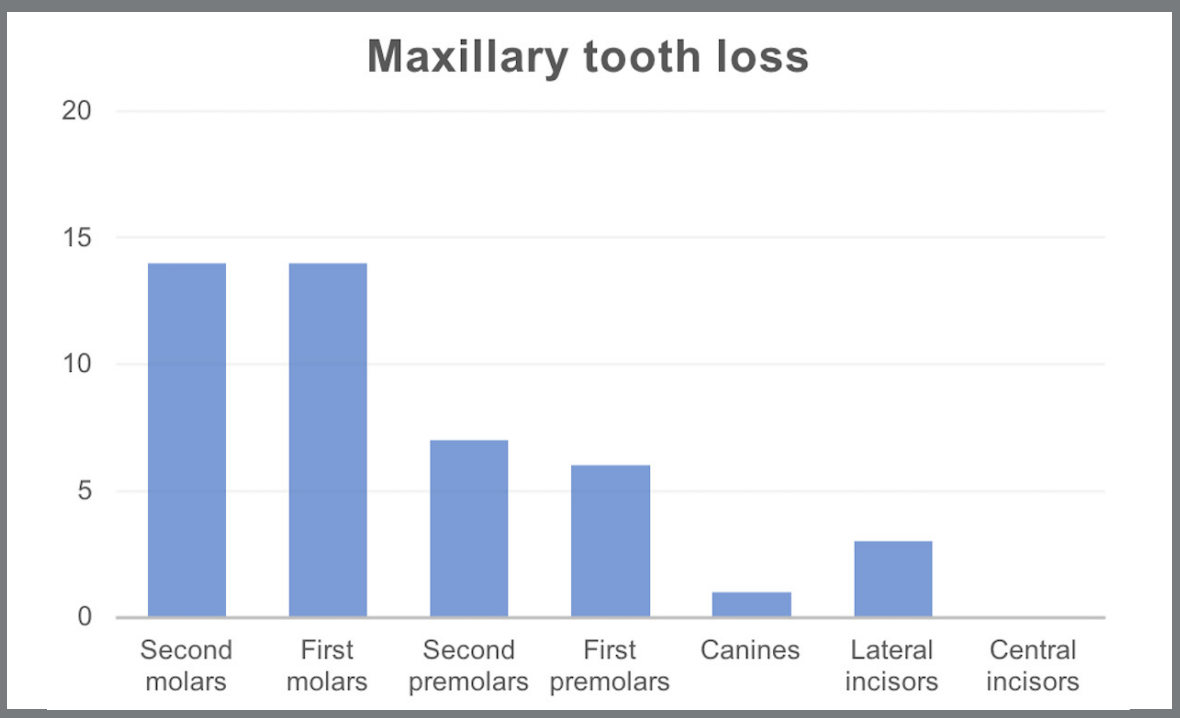
TOOTH LOSS

As age increases, the risk of tooth loss also increases. However, the aging process itself is also not the main predictor for tooth loss. A prior report from United States National Institute of Dental and Craniofacial Research, using a sample from the National Health and Nutrition Examination Survey, reported a mean number of teeth of 26.6 for adults aged 20

to 39 years, 23.9 teeth among adults aged from 40 to 59 years, and 19.4 teeth among adults aged more than 60 years.[49] A previous study showed an association between advanced age and edentulism.[50] Relative to the subgroup aged 50–59 years, older adults aged 60–69 years presented 1.65 the odds of edentulism, while the older subgroup aged ≥80 years presented 5.84 the odds of edentulism.[50] Interestingly, individuals without edentulism showed an increase in the prevalence of oral health care visits with aging, when the opposite occurred to the group with edentulism.[50] This finding reinforces the importance of regular visits to an oral health care provider during the aging process.

In our longitudinal assessment of subjects with normal occlusion, the mean number of tooth loss per individual was 2.1 at the age of 60.[9] In the total sample of 20 subjects with normal occlusion, only 6 demonstrated no permanent tooth loss at 60 years of age. When comparing the region of tooth loss, mandibular and posterior teeth tended to be more affected (Fig 6). In total, there was 42 tooth loss in the complete sample, and only 11 were rehabilitated.[9] The subjects of our sample aged in a time with higher rates of dental caries and numerous tooth extractions. Also, the marked changes in preventive dentistry that happened in the past years —due to water fluoridation, use of fluoride dentifrices, self-perception of oral hygiene and regular use of dental services and technologies— were not experienced by our sample.[51,52]

A health aging process and professional and self-monitored oral care may increase oral health. In addition, the chance of periodontal disease and the number of tooth loss with aging may decrease. Although there is a marked increase in tooth loss with aging, there is a current tendency to decrease the overall rate of tooth loss in the population worldwide.



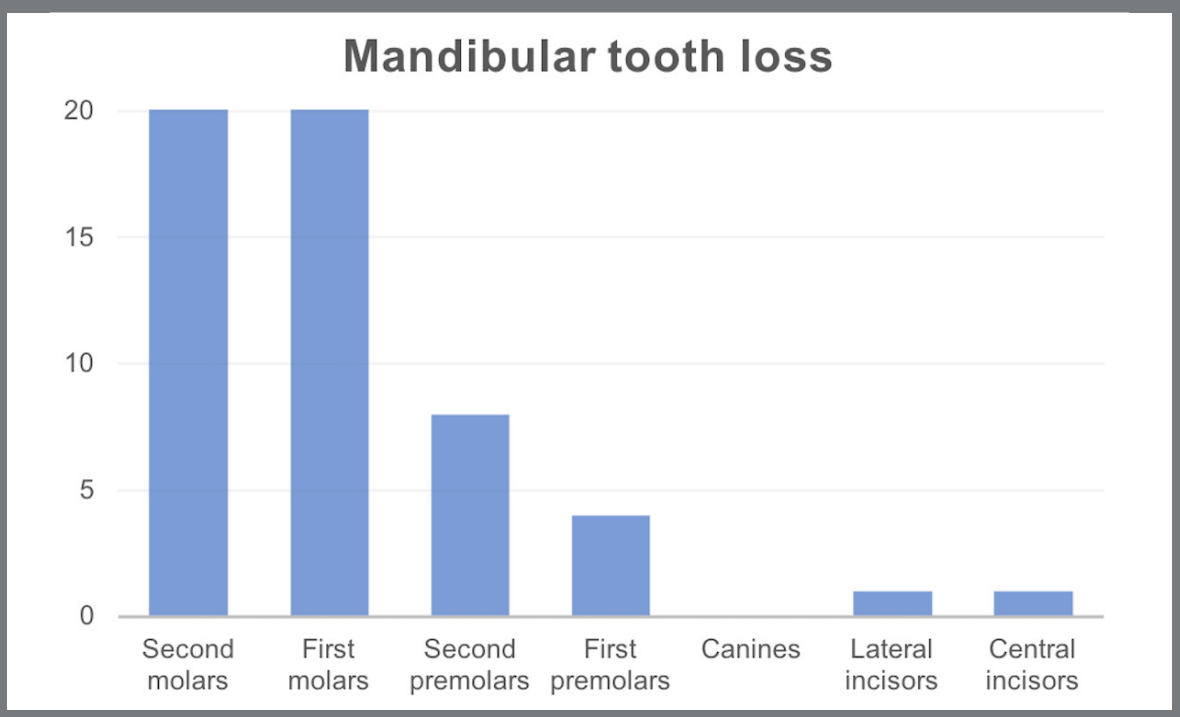


Figure 6: Maxillary and mandibular tooth loss observed at 60 years of age in the sample of nontreated subjects with normal occlusion.

ENDODONTIC CHANGES

Changes in the pulpodentinal complex are expected with aging. With time, a continuous degeneration of the pulp takes place, related to physiological and pathological changes. A reduction of pulp space due to the deposition of secondary and tertiary dentin is observed.[53] Physiological aging factors, as tooth occlusion, attrition, trauma and dental caries, may influence the reduction of the pulp space. Pulpal calcification and loss of pulp vascularity and cellularity are also common findings for older individuals.[54-56] The dentin structure presents some changes with aging.[57,58] The inter-tubular/peritubular dentin become narrower with age, and consequently the strength and energy to fracture dentin decreases with age.[57]

AGING OF THE OCCLUSION

INTERARCH CHANGES

Considering that aging affects the face, the dentition and the dental occlusion, it is important to understand how this process changes the interarch relationship. Our longitudinal follow up of the maturational effects in the occlusion showed that important changes may occur in both vertical and anteroposterior perspective.[8,9]

Overbite

Our longitudinal assessment of the overbite changes after adolescence showed a decrease in the vertical overlapping of the mandibular anterior teeth by the maxillary anterior ones.[8,9] The overbite was measured at 13 (T1), 17 (T2) and 60 (T3) years of age in 22 subjects presenting with normal occlusion. The overbite decreased 1.4 mm from 13 to 60 years of age; from 13 to 17 years of age, the mean decrease was 0.7 mm; and from 17 to 60 years of age, the reduction observed was about 0.6 mm.[8]

From 13 to 17 years of age, it is possible to suggest that the mandibular growth and the eruption of the second and third molars may contribute for the overbite changes. A reduction of 0.4 mm in the curve of Spee was also observed from T1 to T2, and it may be related to the decrease of 0.7 mm observed in the overbite, in the same interval.[8]

From 17 to 60 years of age, the overbite decrease of 0.6 mm may be related to a late mandibular growth in this period.[8] The wear in the incisal edge of the central incisors with aging may also explain the reduction observed in overbite.

The overbite reduction was slightly greater in men,[8] probably due to a late mandibular growth and a more expressive incisal edge wear in males than in females.

Overjet

The overjet changes were quantitatively assessed at the ages of 13, 17 and 60 years.[8] No changes were observed for the overjet from 13 to 60 years of age, despite the effects of the aging process on the craniofacial complex.[8,9] Mean overjet of 2.8, 2.3 and 2.7 mm was found at 13, 17 and 60 years of age, respectively.[8] The stability of the overjet was observed from 13 to 17, 17 to 60 and 13 to 60 years of age, and it is probably explained by the compensatory anteroposterior movement of the incisors, thus, masking some of the aging effects in the sagittal occlusion.

Qualitative assessment of the interarch relationship

The qualitative assessment of the normal occlusion was performed to verify whether time changes the occlusion or impairs its quality. The Objective Grading System (OGS)[59] and the Six Keys to Normal Occlusion (SKNO)[60] described by Andrews were used to assess the occlusal features of 20 individuals at two time-points (T1, mean age of 13 years; and T2, mean age of 60 years).[9] The following paragraphs show the results for the changes in the interarch relationship, assessed with OGS and SKNO.

The OGS assessment showed no changes in the overjet from 13 to 60 years of age.[9] This stability was observed regardless of tooth losses, and corroborates with that previously reported in the quantitative assessment of the overjet changes.[8,9]

Regarding the qualitative analyses of the maturational changes effect in the interarch sagittal relationship, a slight deterioration of the occlusal relationship was observed from 13 to 60 years of age, according to the OGS results.[9] This change was not verified in the subgroup with no tooth loss,[9] suggesting that a worse deterioration may occur in individuals presenting with tooth loss during their lifetime. A possible explanation for the observed deterioration in the occlusal relationship is the presence of a late Class III malocclusion, resulting in a Class III sagittal relationship and an edge-to-edge anterior relationship. The late Class III malocclusion may be associated with a late mandibular growth and a greater physiologic mesial tooth migration in the mandibular arch.

The longitudinal qualitative assessment of the interarch relationship was also performed with the Andrews' SKNO, using the key 1. Our results showed that at 13 years of age, the presence of key 1 was 52% and, 47 years later, this percentage was 31%. However, no statistically significant difference was observed between the two time-points.[9] It is important to highlight that the present normal occlusion sample was collected in the years 60' and 70', before the "Six Keys of the Normal Occlusion" has been published by Dr. Andrews.[60] Figures 1 and 2 show the occlusion aging for a male and a female individual, respectively.

In summary, during the aging process, a continuous reduction in the overbite, a stability of the overjet and a very slight deterioration of the interarch sagittal relationship were observed.[8,9]

INTRA-ARCH CHANGES

Tooth size

During aging, tooth size changes were observed. Clinical crown height strikingly increased from adolescence to late adulthood, as observed in the subjects of Figures 1 and 2. The increase of crown height varied from 0.5 to 3.2 mm due to passive tooth eruption and to apical migration of the gingival margin.[8]

Conversely, mesiodistal tooth size decreased a mean of 0.3 mm from 13 to 60 years of age.[8] The decrease in tooth width can be explained by interproximal dental wear, and contributes to the arch perimeter reduction during the aging process.

Dental crowding and arch dimensions

The normal occlusion changes with aging were very slight.[8] The most notable change was the mandibular incisor crowding (Figs 1 and 2). From the second to the seventh decade of life, mandibular incisor crowding increased by 2.5 mm, probably associated with the decrease of both intercanine distance and arch perimeter. Mandibular intercanine distance

decreased approximately 0.7 mm from 13 to 60 years of age.[8] The decrease in mandibular arch perimeter was 2.8 mm in the same age interval.[8]

Maxillary late incisor crowding was minor, around 1 mm, even though the maxillary arch perimeter decreased by 3.5 mm.[8] It can be speculated that maxillary incisors lost some mesiodistal angulation, becoming more upright to compensate the arch size reduction. Arch widths remained stable in the maxillary arch.[8] The stability of maxillary incisor alignment in the long-term is an important esthetical advantage during aging in individuals with normal occlusion.

A questionnaire of esthetic self-perception was applied at the age of 60. All patients claimed to be satisfied with their smiles. In a scale from 0 to 10, the average self-score for the smile was 8. When the subjects were asked for dental complaints, the most frequent was tooth coloring. No patient had the desire to undergo orthodontic treatment.

Individual tooth changes

In the maxillary arch, second molars showed a three-dimensional change in position during aging. Some subjects demonstrated a slight buccal displacement of maxillary second molars from the ages of 13 to 60.[9] A possible explanation for second molar buccal displacement is the third molar eruption, due to

its volume. A mesiodistal angulation change of maxillary second molars was also noted.[9] Adolescent patients commonly showed distoangulated maxillary second molars. Maxillary second molars uprighted with aging, possibly in response to the decrease in the maxillary arch perimeter. In other words, the distoangulation of maxillary second molars was attenuated with time, and some subjects only demonstrated an "ideally" mesioangulated second molar at the mature age.

Superimposition of mandibular dental models taken at 17 and 60 years of age showed that adults display a significant tooth eruption relative to the mucogingival junction for both anterior and posterior teeth, ranging from 0.8 to 1.2 mm.[61] Transverse dental movements included a very slight lingual displacement of canines and premolars. Anteroposterior movements of mandibular teeth were not significant, except for molars, which moved mesially.

Interestingly, when we analyze men and women separately, the sagittal movement of mandibular incisors during aging seems to be a discriminant factor. In all men, the mandibular incisors slightly moved lingually, while in all women, incisors moved labially. Therefore, during maturation, mandibular incisors seem to compensate the mandibular anterior displacement in men and the backward rotation of the mandible in women.[61]

CLINICAL IMPLICATIONS OF OCCLUSION AGING

Aging is a dynamic process. Important changes occur in the face, tooth and occlusion, as described earlier. In Dentistry, patients have been increasingly looking for treatments to soften the aging effects in their smile.

An important aging change in the dentition noticed by the individuals with normal occlusion from adolescence to the mature age was the incisor crowding.[9] Additionally, late anterior crowding is frequently reported as an expected maturational change of the occlusion in treated and untreated individuals.[8,9,62,63] With aging, incisor alignment is deteriorated even in untreated subjects presenting with no crowding in the adolescence.[8,9] These findings are more evident in the mandibular dental arch, and are probably explained by the decrease in the intercanine distance caused by the lingual movement of the canines with aging, as demonstrated with the dental model superimposition of subjects with normal occlusion at 17 and 60 years of age.[61] Consequently, bonded lingual retainers should be recommended for adolescents and young adult patients with no need of orthodontic treatment, if they intend to maintain the mandibular incisors aligned.

If no retainer is used in the mandible from adolescence to the sixties, there is a considerable risk that a deterioration in incisor alignment will be observed and become a later complaint.

The comprehensive orthodontic treatment of the late crowding is a viable option to correct the incisor alignment and has become increasingly common among young and mature adults. Full fixed appliances, partial fixed appliances and aligners are some of the treatment options to be presented to patients. The decision between treating or not treating the late incisor crowding depends on the patient's perception and complaint.

With aging, teeth tend to discolor (Fig 5).[43,44,64] The tooth enamel is a porous surface susceptible to wear and staining.[55] In addition, the gradual erosion of the enamel of the teeth exposes the yellow dentin with age. In Dentistry, teeth whitening is considered a safe and conservative treatment to successfully bleach patient's natural teeth.[65] An adequate examination and diagnosis is recommended to investigate the cause of discoloration of the teeth and define the best treatment option, as well as the intervention prognosis.

Another important clinical implication of the aging process in the occlusion is the increase in the clinical crown height.[8] Considering the spontaneous apical migration of the gingival margin, surgical crown lengthening procedures should be indicated with caution in young patients.

In addition, procedures in Orthodontics and Operative Dentistry aiming to reduce tooth wear should be considered. For example, clinicians should keep in mind that the augmentation of canine cusp tips can minimize the wear of the incisal surface of the incisors. Incisors and canines with incisal edges worn down with aging should also be augmented, to maintain an adequate smile arc. Important details of pleasing smiles are associated with the size and proportion of the incisors, as well as the gingival level of the anterior teeth.[66] Additionally, the incisal level of the maxillary central and lateral incisors also influences the esthetics perception of the smile.[66] With aging, tooth wear may change the shape and size of the anterior teeth.[8,67,68] Therefore, the reconstruction of anterior teeth with worn edges may improve the smile esthetics, and camouflage the aging signs in adults.

The cephalometric assessment of individuals with normal occlusion from 17 to 60 years of age showed upper and lower lip retrusion, as well as a decrease of upper lip thickness, as mentioned earlier.[33] Considering these findings, orthodontists should avoid an extreme retrusion of the incisors during orthodontic treatment, in order not to anticipate facial aging.

In addition, maxillary incisor exposure relative to the upper lip decreased in the same period (approximately 1mm every decade).[33] Dental wear in the incisal surface of the incisors, as well as the changes in the upper lip position with age, explains these results. For this reason, clinicians should be very careful when indicating intrusion of the maxillary incisor during comprehensive orthodontic treatment, in order to prevent accelerating facial aging or jeopardizing the smile esthetics at mature ages.

In Orthodontics, another clinically relevant finding was the spontaneous correction of the maxillary second molars distoangulation with age.[9] Initially, most of maxillary second molars presented with a distoangulation of the crown. After eruption, and during adolescence and early adult age, a natural tendency of maxillary second molars uprighting was observed. After 40 years of follow-up, these teeth showed a normal positive angulation.[9] This finding has to be considered in the orthodontic treatment planning of patients during early permanent dentition.

CONCLUSION

The follow-up of normal occlusion subjects from adolescence to the seventh decade of life revealed that maturational changes in the nontreated occlusion are delicate. A slight mandibular crowding, a decrease in overbite, changes in the maxillary second molar position, an increase in the crown length, and dental wear and discoloration were notable. Compared to remarkable facial and skin changes during aging, the occlusion seems to be the most stable feature of the face during the aging process. An adequate oral care throughout life can make the smile the best memory of youth in a mature individual.

AUTHORS' CONTRIBUTIONS

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Conception or design of the study:

DG

Data acquisition, analysis or interpretation:

CM, FM

Writing the article:

DG, CM, FM

Critical revision of the article:

DG, CM, FM

Final approval of the article:

DG, CM, FM

Fundraising:

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Overall responsibility:

DG

Patients displayed in this article previously approved the use of their facial and intraoral photographs.

The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

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