Chapter 4 Growth and development of the craneofacial region and the stomatognátic apparatus

Capítulo 4 Crecimiento y desarrollo de la región craneofacial y el aparato estomatognático

TORRE-MARTÍNEZ, Hilda†*, THERIOT-GIRÓN, María de Carmen, CARRILLO-GONZÁLEZ, Roberto and MENDOZA-TIJERINA, Adrian

Universidad Autónoma de Nuevo León, Mexico

ID 1st Author: *Hilda, Torre.Martínez* / **ORC ID:** 0000-0002-4147-7310

ID 1st Co-author: *María de Carmen, Theriot-Girón*

ID 2nd Co-author: *Roberto, Carrillo-González*

ID 3rd Co-author: *Adrian, Mendoza-Tijerina*

DOI: 10.35429/H.2021.13.36.56

H. Torre, M, Theriot, R. Carrillo and A. Mendoza

* dratorrem@gmail.com

A. Marroquín, J. Olivares, M. Cruz, L. Cruz. (Coord.) CIERMMI Women in Science TXIII Medicine and Health Sciences. Handbooks-©ECORFAN-México, Querétaro, 2021.

Abstract

The purpose of this chapter is to recall the importance of craniofacial growth and development in the human being, that is why concepts and monitoring of this important process are included. It is a compilation of information obtained on the basis of knowledge obtained from the literature as well as from the authors, it can be said to be a systematic review of information or frame of reference. This is a contribution to the academic training of students and a brief journey through time on this topic for dentists in practice and teachers in this area. It is concluded that growth and development in the theoretical aspect is very important to apply in practice the knowledge obtained and remembered in this contribution.

Growth, Development, Cephalometry, Cephalometry

Resumen

El presente capítulo tiene como objetivo recordar la importancia del crecimiento y desarrollo cráneo facial en el ser humano, es por eso que se incluyen conceptos y y seguimiento de este importante proceso. Es una recopilación de información obtenida en base a los conocimientos obtenidos en la literatura como en los de los autores, se puede decir que es una revisión sistemática de información o marco de referencia. Con este se contribuye a la formación académica de los estudiantes y un breve viaje en el tiempo acerca de es te tema para los odontólogos en consulta y los docentes en esta área. Se concluye que el crecimiento y desarrollo en el aspecto teórico es muy importante para aplicar en la práctica los conocimientos obtenidos y recordados en esta aportación.

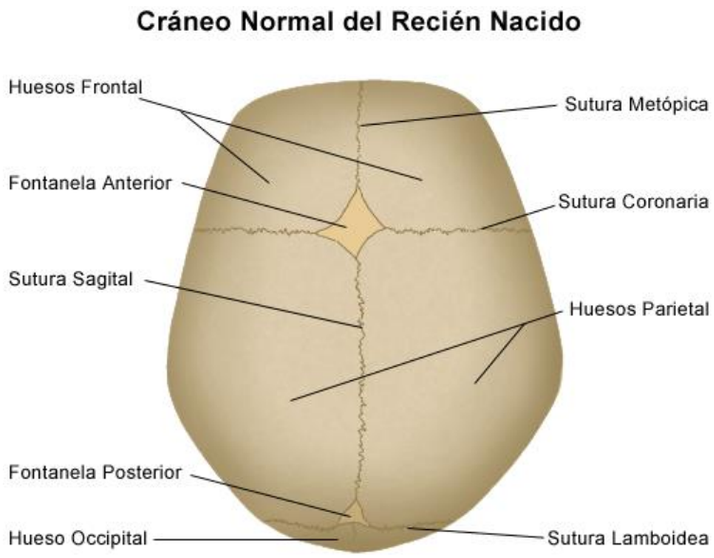
Crecimiento, Desarrollo, Cefalometría

4.1 Introduction

To practice dentistry it is necessary to have a broad knowledge of craniofacial growth and development. Although dentistry has many specialties, it is important to have the knowledge even when not working with children, since many of the disorders in adults are originated from development.

Most, if not all, dentists have contact with children, so it is important to know how to distinguish normal processes from the effects of abnormal or pathological processes.

Figure 4.1 Skull of a new-born



Both orthodontists and pediatric dentists will be able to beneficially manipulate the facial growth of patients when they have the knowledge of the norms of growth and the mechanisms that are related to it. The knowledge of the growth of the craniofacial skeleton is a complex and essential process for diagnosis and treatment in interceptive or preventive orthodontics. (1)

First of all, we must differentiate the terms growth and development because although they are totally linked they are different terms, growth refers to an increase in size or number, it is an anatomical phenomenon, it is the increase in the dimensions of the body mass (size, height and weight) this is due to hypertrophy and hyperplasia of the constituent tissues of the organism, The basis of this process is the cellular differentiation, sometimes the increase will not be neither in size nor in number but in complexity, then we will be talking about development which is an anatomical phenomenon, it is the change in the physical proportions, quantitative and qualitative changes that take place in the human organism and that bring at the same time an increase in the complexity of the organization and interaction of all the systems. The basis of this process is cellular differentiation, which leads to the maturation of different physical and psychological functions, a quality that gradually leads to the improvement of functional capacity. It also refers to unidirectional changes that occur in a living being from being constituted as a simple cell until death, when referring to complexity we speak of development, growth and development are not independent, but represent a continuity of interactions of processes that cause changes in form and functions of all tissues of the body and includes the increase of the individual's capabilities and adaptations acquired in the process towards maturity. (1,2,3)

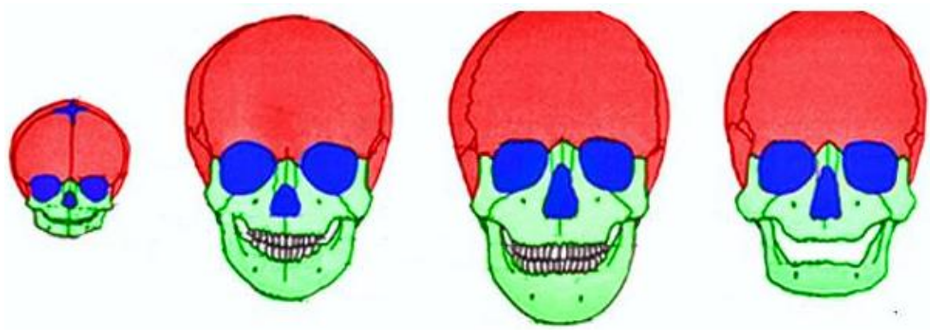
Craniofacial development and growth derives from a series of morphogenetic processes in intrauterine life and after birth these achieve a functional and structural balance between the hard and soft tissue of the craniofacial region. Since the bones of the craniofacial complex are in constant growth before the action and internal and external circumstances in order to preserve the balance during childhood and adulthood. (1)

4.2 Growth: patterns, variability and chronology

When we talk about growth we use the word pattern, which is a scheme that is followed to make a dress, shoes, artificial teeth, etc. Therefore, the pattern of growth refers to the changes that spatial proportions undergo over time, that is, there is a superior organization.

During fetal development by the third month the head represents 50% of the total body length, the skull is large in relation to the face and represents more than half of the total head, the limbs and trunk are underdeveloped (Figure 4.1). As time goes by, the head decreases to 30% and the trunk and limbs grow faster. When the moment of birth arrives the legs reach 1/3 of the total length of the body, in the adult represent 1/2 the legs grow more than the arms during the postnatal life, these changes reflect the cephalocaudal gradient of growth, that is to say the increase is from the head to the feet. (3,4)

Figure 4.2 Developmental changes of the head from newborn to adult



Muscles and bones grow faster than the brain and the central nervous system, which indicates that there are different growth gradients found in different parts of the body, the tissues are different and grow at different rates. With respect to the head and face it can be observed that the changes are very noticeable when comparing the proportions of a newborn with those of an adult, the child has a larger skull (80% development) than the size of the face (20% development), later on the facial growth pattern will make the proportions more accentuated in the growth of the face than in the skull.

Growth patterns are predictable because they repeat themselves, similar to a geometric pattern where the only difference lies in the addition of the temporal dimension. A change in the growth pattern will indicate an alteration in the predictable and predictable sequence of changes that can be expected in an individual. (4)

Variability is a concept to keep in mind when studying growth and development, individuals are not alike in the way they grow, think and do, it is very important to decide whether the individual represents an extreme of normal variation or exceeds normal limits. Therefore, it is better to use the term variability to indicate deviations from a growth pattern and not to classify individuals into normal and abnormal. There are charts and graphs to assess a child's growth and development that were designed in a standardized way, specifically for height and weight, and can be made for any part of the body.

Based on these graphs it can be established if the child is growing normally when it is within the limits of normality of these graphs, if the child's height and/or weight are higher or lower, the professional should consider the possibility of a growth abnormality. (1)

Timing is another important term in growth and development. Variations can affect growth in several ways: normal variation, by influences outside the normal experience (serious illness) and by their effects depending on the time at which they occur. Chronological variations are those in which the same event affects different individuals at different times, with the biological clocks of individuals functioning differently.

In adolescence it is possible to see chronological variations in growth and development more easily. Occasionally some children grow and mature more rapidly, establishing and completing their growth and appear in the charts and graphs in the higher zones, which will be temporary as they will be overtaken by peers. Some other children grow and mature more slowly and fall behind but will suddenly grow up and leave the taller children behind. This growth spurt, which all children tend to have, happens at different times for each child.

In girls, the phenomenon of chronological variation can be observed more easily, since the onset of menstruation, also known as menarche, indicates the onset of sexual maturity, which is accompanied by an acceleration of growth. Girls also show gender differences, with some maturing earlier than others and surpassing the pubertal growth spurt, while late-maturing girls have not begun to grow rapidly. Chronological variation that occurs in many forms contributes to variability. Age is usually measured chronologically with elapsed time in years, but it is also possible to measure it with the series of markers or developmental stages that are used to do so biologically.

A range of ±2 years on average is considered normal. Therefore, for girls the onset of the outbreak may be between 9-13 years and for boys between 9-15. The value of this range of values is as in many biological distributions a normal distribution.

It is possible to reduce chronological variability by using developmental age as an expression of an individual's development. When it is possible to do this, a table of sexual development using a biological time scale is used and the pattern is shown to be expressed at chronologically different, but not physiologically different, times. (1)

4.3 Methods for studying growth

To perform the study of craniofacial growth and development there are two methods; one that is based on the specific measurement techniques of live animals including humans, without being detrimental and the study subject can be used for other measurements.

The other method of measurement is the one that is performed by manipulating the growth is based on experimentation, the subject on which is experimented most of the time is sacrificed, so many of the experimental studies are performed on animals.

Measurement methods

Craneometry

Physical anthropology (called craniometry) began with methods of measuring the skulls of human skeletal remains, especially used to study the skulls of Neanderthal and Cro-Magnon men found in Europe in the 18th and 19th centuries. With this, a great deal of information has been obtained about the extinct beings and to determine something about growth patterns by making comparisons.

Craniometry allows measurements on dry skulls which are usually quite accurate, the main disadvantage is that the measurements are usually in cross section, even if the skulls or representations are of several individuals they can only be measured once. (1)

Anthropometry

Anthropometry measures in living individuals various parameters established in studies with dissected skulls, in this case the soft tissue areas that cover the bony points of reference are used. As an example, the length of the skull can be measured from the bridge of the nose to the maximum convexity of the back of the skull. Such a measurement can be performed on a living individual as well as on a dry skull, there will be some differences mainly found with respect to the existence of soft tissues.

With this type of measurement, several measurements can be taken on the same individual at different times at the same points, thus performing longitudinal studies.

Farkas in recent years has conducted very interesting studies on facial proportions and their changes over time. (1,5)

Cephalometry

It is an important measurement technique since, in addition to assessing growth, it supports the study of orthodontic patients. It is based on the exact orientation of the head before performing an X-ray with controlled magnification.

It combines craniometry and anthropometry, measures skeletal bone dimensions, since in the X-ray the bone can be seen through the soft tissues that cover it, allowing the individual to be followed over time. Cephalometric studies are carried out by superimposing a digital model or tracing a posterior cephalogram over an anterior one, measuring the changes, observing the locations and the degree of growth.

A drawback of cephalometric radiography is that it gives a two-dimensional image of a three-dimensional one even when the head is well positioned. However, this problem can be solved by taking several radiographs in different orientations and using triangulation to calculate oblique distances. (1, 6,7)

3D three-dimensional images

In this super-modern era, measurements are obtained using three-dimensional techniques. Computed axial tomography (CT) allows reconstruction of the skull and face in 3D, and has been used for years in the design, planning and surgical reconstruction of patients with facial deformities. (1)

Hand radiography

Any part of the body can be used to determine bone age, but in practice the hand and wrist are the most commonly used, because they have several bones and epiphyses in development, which allows tracking the changes that occur through growth. They are the most convenient areas to assess bone maturation, as they are far from the gonads and require less radiation. Radiographs of the left hand and wrist are taken because they are less influenced by external factors, considering the higher proportion of right-handed patients. Although Greulich and Pyle show very little difference between the bone growth of the right and left hand. (8)

4.4 Stages of growth and development

In growth and development, the limits between them are not precise and present special characteristics. Growth presents 3 main stages.

Childhood, adolescence and cloudiness or youth. (4)

First stage: infancy

Early Childhood: from birth to 3 years of age and the changes observed are:

Eruption of primary teeth and completion of the primary dentition.

The increase in height by more than 40% in the first year is the largest of all the child's growth.

Increase in height from 50 cm to 1m.

Weight gain from 3 to 12 kg.

Second childhood: from 3 to 6 years of age.

This completes the deciduous dentition and initiates the mixed dentition with the eruption of the 1st permanent molar at 6 years of age.

The increase in height and weight is less than in early childhood, being 25 to 30 cm and 6 to 7 kg, respectively.

25 to 30 cm and 6 or 7 kg. respectively.

Increased growth in width.

Apparently stationary dental evolution.

Head volume is very large in relation to the overall size.

Third Childhood: in girls it is from 6 to 11 years of age and in boys from 12 or 13 years of age.

The primary dentition is replaced by the permanent dentition, a period known as mixed dentition. Head growth slows down.

Longitudinal increase of the skeleton in relation to transverse growth. (4,9).

Second stage: adolescence

Pre-puberty:

It lasts 2 years and appears first in girls, it is a time of important changes in the organism, from 11 to 13 in women and from 12 to 14 in men.

In men.

Increased growth of the lower extremities.

Increase in height of approximately 7 cm per year.

Puberty.

From 13 to 15 years of age in females and from 14 to 16 years of age in males.

Maturation of sexual organs and manifestation of sexual characteristics such as menarche and first ejaculation.

From the dental point of view very few changes are observed, although in some processes it is possible to find the budding of the 3rd molars in our environment.

Post-puberty: The individual completes its transformation and acquires its definitive shape and proportions and proportions, it goes from 15 to 18 in females and from 16 to 20 in males.

20 in males.

Adolescence is the most important time of growth and development, as the major evolutionary crises of some organs occur.

The major evolutionary crises of some organs take place.

The permanent dentition is established and there is some remaining growth of the jaws.

Second stage: cloudiness. -youth 18 years old until 25 years old

The growth is relative and the individual reaches the definitive height and proportions. The only dental change may be the eruption of the 3rd molars and the remaining growth of the jaws is very reduced.

Adult Age. Between 25 and 60 years of age.

Period of functional balance, growth is complete and the individual reaches his greatest physical, intellectual and genital strength. During all stages the individual undergoes changes in physical body proportions such as that of the head in relation to the total size and of the face in relation to the total volume of the head. (1,3)

4.5 Areas and types of craniofacial growth

It is important to know: 1. the areas of growth, 2. the type of growth that occurs in that place, 3. and the factors that determine or control such growth.

The facial skull complex can be divided into four regions that grow in different ways:

1. Cranial vault, the bones that cover the external surface of the brain.

2. Base of the skull, the bony floor beneath the brain, which is also the dividing line between the skull and the face.

3. Naso-maxillary complex, consisting of the nose, the maxilla and associated bones.

4. Jaw.

Mechanism of bone growth

Sites of craniofacial growth and remodeling

During craniofacial development and growth, it is necessary to take into account how the displacement and translation of the craniofacial complex takes place, since it is influenced by several factors that are of great importance for dentists to know since they act on the stomatognathic system.

During growth there are remodeling functions that are linked to childhood, most of which also last until adulthood. Facial growth is a process that requires close morphogenic interrelationships between hard or soft tissue that grow, change and function. No element is self-sufficient and independent in terms of development; a continuous state of structural and functional equilibrium is fundamental and important in growth. (1, 4,9)

Bone growth is a cumulative process of resorption, apposition or deposition of bone accompanied by remodeling, resulting in the displacement of bone, as a bone increases in volume, at the same time moving away from other bones in contact with it. This movement is given by the apposition of new bone on one side of the cortex and resorption of the opposite side, producing a real movement of growth that indicates the increase of the dimensions of the whole bone.

During the enlargement of the craniofacial bones two types of growth movements are seen:

Cortical creep and displacement

Creep: Creep is the movement of bone that is the result of the combination of deposition of new bone on one side of the cortical lamina and resorption on the opposite side, this happens throughout the growth zone of a bone and is not located in the main growth centers, it produces generalized augmentation, as well as relocation of the points involved. Dragging occurs simultaneously with displacement, but they are different as they are distinct ways of movement of the whole bone as a unit.

Remodeling: During remodeling, the amount of bone deposition is greater in relation to bone resorption, so that regions of a bone gradually increase and the cortical laminae present greater thickness as soon as they are remodeled.

Remodeling is a fundamental part of growth, so that the bone can move, resulting in movement in each bone relocating them from one site to another. Therefore, growth and remodeling are inseparable parts, so the bone must present an external periosteal surface of resorption and apposition which need not be carried out with the same intensity.

The growth activity can be observed that some areas of the different bones grow faster than others, therefore there are areas of greater importance in the growth that are called "growth sites", for example, the condyle is one of these sites, however, growth does not occur only on certain surfaces, All bone surfaces are specially designated growth sites because during growth apposition is greater than resorption and as bone size increases, acting on the expansive force of all the soft tissues surrounding the bone determines the rate of the growth remodeling process that surrounds the bone and displaces it, physiological actions applied on the bone, leading to apposition of new bone on the contact surface. All particular contacts and bone ends have fundamental importance in growth, from these same points the displacement continues and at the same time the places where the remodeling lengthens a particular bone. And in this way continuous regional structural adjustments of all portions of the bone are made in order to achieve proper adaptation for future intrinsic and extrinsic changes during growth. (3,410)

The bone surface oriented towards the actual direction of growth receives new bone deposit there is bone apposition, while that which is away from the course of growth is resorbed, and in this way the bone can migrate or displace which is the movement of a whole bone as a unit and simultaneously maintain relationships with neighboring bones in relation to a fixed structure, whereby the individual bones are kept in constant articular union. (1, 3,4)

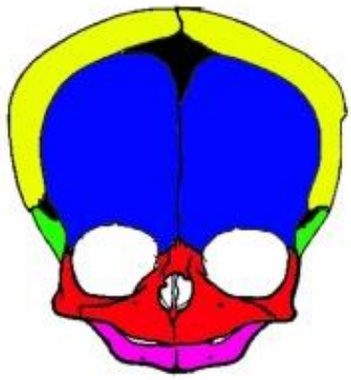
Cranial bowl

The cranial vault is constituted by a series of flat bones that originate directly by intramembranous bone formation without cartilaginous precursors, the growth process is the result of periosteal activity on the surface of these bones. At birth the cranial vault is asymmetrical due to the pressure to which it is subjected during birth, this is corrected with post natal growth, so it changes shape in the first two years of life, when the child is born the bones of the skull are separated by lax intermediate connective tissue (figure 2).

At the moment of birth the skull can be deformed thanks to these spaces called fontanelles, the head is very large and with this deformation the baby can descend through the birth canal. The skull enlarges due to the pressure exerted by the growing brain and its primary function is to protect it. At birth the sutures between the bones are separated by fontanelles, which are membranous spaces in the skull. The growth of the cranial vault is (according to Brodie) concentric.

After birth, there is bone apposition along the fontanelles and the open spaces are rapidly being eliminated, however the bones are still separated by a thin periosteal covered suture which in adulthood fuses, the apposition of newly formed bone at the sutures and the main mechanism of growth of the cranial vault, remodeling and growth occur at the periosteal covered contact zones that exist at the cranial sutures, hence it is sutural development. (4,11)

Figure 4.3 Skull of the newborn



The growth of the cranial vault is determined by environmental factors and in the same way as the previous ones is based on membranous growth centers in the region and simultaneously begins the ossification of the sutures that are found between them, which will be constituted in: growth centers, areas of flexibility and future movement of the cranial vault. Thus, the coronal, sagittal, occipital, metopic, bregmatic, lamboid, pteric and asteric sutures will become potential areas of expansion of the cranial vault during the first years of life, or areas of growth limitation that give rise to cranial malformations due to their premature closure.

Growth in width

There is apposition on the external surface, and resorption on the internal table, growth of the medial sagittal suture between the parietal bones and of the sagittal suture between the frontal bones (Figure 3).

Growth in height

It is carried out by growth of the cranial sutures: fronto-sphenoidal, parieto-sphenoidal, parietotemporal and parietooccipital, and to a lesser degree by apposition on the external table of the cranial vault.

Growth in length

It is at the level of the coronary-frontoparietal suture, compensating the increase in length of the skull base and there is little remodeling, mainly adjacent to the suture. (1, 3,4)

Figure 4.4 Cranial vault width and height growth

Skull base

Growth of the cranial base (condocranium)

Linked to the vault, they share the function of protecting the brain, but are also articulated with the spine, the mandibular condyle and the nasomaxillary complex.

The bones at the base of the skull are formed from cartilage and are transformed into bone by endochondral ossification, which affects the midline structures.

When laterally displaced, suture growth and surface remodeling are more important, the skull base is a midline structure.

At the beginning of intrauterine life the growth centers of the chondrocranium appear, definitively locating the bones: ethmoid, sphenoid and the basilar portion of the occipital. As ossification progresses, bands of cartilage called synchondrosis appear between the ossification centers. The most important are the spheno-occipital synchondrosis between the sphenoid and the occipital, and the intersphenoidal synchondrosis between the two parts of the sphenoid, which ossifies before or immediately after birth. And between the sphenoid and ethmoid the sphenoethmoidal synchondrosis, the area between the two bones is formed by growing cartilage. The synchondrosis has a zone of cellular hyperplasia in the center, with bands of chondrocytes and maturation extending in both directions that will be replaced by bone.

Immobile joints develop between the bones of the skull base, unlike the bones of the extremities which develop extremely mobile joints. The base of the skull resembles a long bone, with the difference that it has multiple synchondroses that are similar to epiphyseal plates. There are immobile joints at the base of the skull, the exception being the mandible. The periosteum-covered sutures at other points that do not contain cartilage are quite different from the cartilaginous synchondroses. (4)

Growth in width of the skull base

The temporo-sphenoidal and temporo-occipital synchondrosis contribute to the width of the base, in addition to the superficial apposition. Temporo-occipital synchondrosis, in addition to the superficial apposition.

Growth in height of the base of the skull.

The height of the base is given by the surface apposition.

Growth of the skull base.

Until early childhood, the spheno-ethmoid synchondrosis plays a fundamental role in the growth in length of the cranial base.

The growth in length of the cranial base, later and up to about 20 years of age, the main the main anteroposterior growth of the skull base is due to the spheno-etmoid synchondrosis.

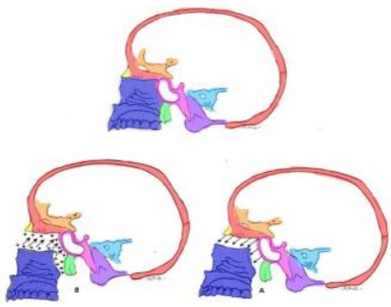
The skull base is due to the spheno-occipital synchondrosis (Figure 4). Bone apposition processes with their corresponding resorption are also involved.

Figure 4.5 Skull base growth

Growth of the facial mass and jaws

The growth of the face is purely membranous, because of this environmental factors may simply contribute to the development of shape and growth. Because of this developmental process it can be differentiated that the face is small in comparison with the skull due to the lack of development of the paranasal pneumatic sinuses and the reduced size of the bones, this is more evident in the maxillae, but with the appearance of the teeth and the development of the paranasal air cavities the face acquires its infantile features. (4,11)

Figure 4.6 Direction of growth of the middle third of the face



Growth of the nasomaxillary complex

The maxillae develop from the lateral membranous tissue of the cartilage of the nasal capsule by the end of the sixth week of fetal life.

Nasal capsule at the end of the sixth week of fetal life, where the canine will form.

From this point on, ossification will occur in all directions.

The jaw proper (premaxilla, maxilla and palate) is the result of a highly complex growth pattern with many different components.

Highly complex growth pattern with many different components.

The development of the orbital cavities is virtually complete at birth.

Birth. The nasal cavity is located between the two orbits, and its floor is at the level of the is at the level of the fundus. The alveolar process is only faintly discernible and the palate has a weak transverse curvature. The maxillary body is completely filled with dental development. The paranasal sinuses in sense, are still deficient, although they are a depression in the floor of the nasal floor of the nasal cavity, indicating their future position.

Deep facial growth

In relation to the cranial base, maxillary growth occurs in an anteroinferior direction, although with great individual variations.

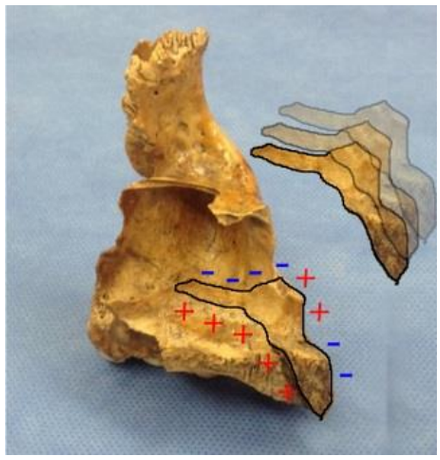
Anteroinferiorly, although with great individual variations. The anterior the anterior growth is mainly the result of displacement of the maxillary bodies (Figure 5). Maxillary bodies (Figure 5). The dimensional increase in the maxilla occurs mainly posteriorly by bony apposition at the tuberosities and their adjacent sutures. The alveolar base is also elongated, creating space for later erupting teeth.

The anterior surface of the maxilla, on the other hand, is stable from the growth point of view, and only shows variations in the remodeling pattern (Figure 6).

Growth point of view, and only presents variations in the remodeling pattern (Figure 6).

The position of the anterior contour of the zygomatic process is also markedly stable in relation to the maxillary body. (3)

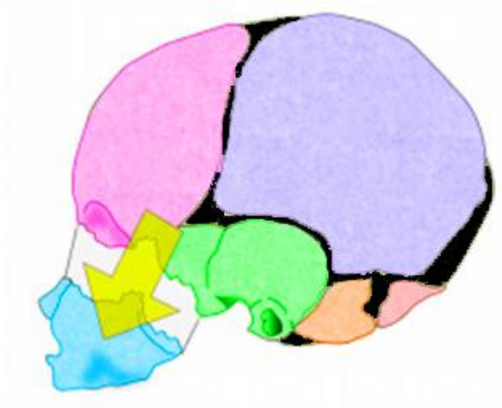
Figure 4.7 Maxillary apposition - AND resorption



Growth in height of the face

The vertical growth of the midface in relation to the anterior cranial base is the combined result of the downward movement of the maxilla as a whole by displacement and remodeling of the bony surfaces, is the combined result of downward movement of the maxilla as a whole by displacement and remodeling of the bony surfaces. The displacement of the displacement of the maxilla, classified as sutural descent of the bone, generates space for expansion of the nasal cavity and orbits (Figure 4.7).

Figure 4.8 Downward direction of maxillary growth



Sicher states that the growth of the nasomaxillary mass is due to 4 pairs of parallel sutures (Fig. 4.8) that join the skull and face and push the nasomaxillary complex forward and downward to adapt its growth with the mandible (Figure 4.8):

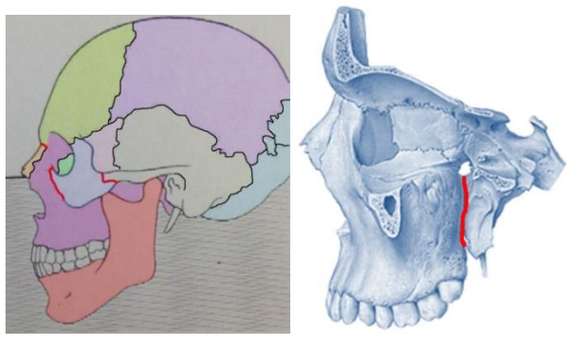
1. Frontomaxillary suture.

2. Zygomatic- maxillary suture.

3. Zygomatic-temporal suture.

4. Pterygo-palatal suture.

Figure 4.9 Sutures joining the skull and face



The floor of the nasal cavity and the roof of the palate move vertically relative to the orbits. Relative to the orbits. The growth of the alveolar processes is rapid during tooth eruption and exceeds the descent of the roof of the palate by three during tooth eruption and exceeds the descent of the roof of the palate by three times on three times on average, thus accentuating the curvature of the palate. The magnitude of the vertical growth of the alveolar processes and the curvature of the palate show relative individual variation, due to the adaptive capacity of the alveolar process and the dentition alveolar process and the dentition.

On the other hand, Scott considered that the facial sutures could not drive the nasomaxillary complex in its anterior and downward displacement.

Nasomaxillary complex in its anterior and descending displacement. He reasoned that the cartilaginous nasal septum occupies a strategic position that causes the mid-facial region to the midfacial region to move anteroinferiorly as it increases in size.

Increases in size. As the tissue is more pressure tolerant than the sutures, it appears to have the tissue appears to have the developmental capacity to push expansively downward and forward downward and forward the nasomaxillary complex. (3,4, 13)

Moss posits that skeletal tissues grow in response to the growth of soft tissues (subcutaneous and submucosal cellular soft tissues (subcutaneous and submucosal cellular tissue, nasal epithelium, buccal epithelium, vessels, nerves, muscles), vessels, nerves, muscles). (12)

Growth in width

Additional expansion of the nasal cavity occurs by separation of the two maxillary bodies at the medial suture, lateral displacement and of the two maxillary bodies at the medial suture, lateral displacement and bone resorption in the lateral bone resorption in the lateral walls of the cavity. It has been shown that the growth in width of the maxilla at the mid-suture continues until the juvenile stage, between 17 and 18 years of age.

Stage, at approximately 17 to 18 years of age and parallel to the height growth curve. growth curve in height. It has also been shown that the separation of the two bodies is greater posteriorly than bodies is greater posteriorly than anteriorly. (12,13)

Jaw growth

Although still separated by a symphysis in the midline at birth, the two halves of the halves of the mandible fuse between the first and second year of life.

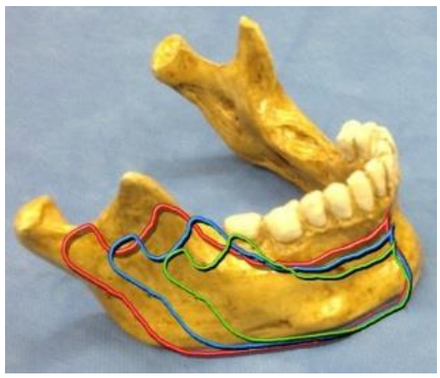
Llife. The alveolar processes and the muscular system are poorly developed at this age, so that the shape of the developed at this age, so that the shape of the mandible in the neonate is mainly determined by its arch.

The shape of the mandible in the neonate is mainly determined by its basal arch. Of all the facial of all the facial bones, the mandibular shows the greatest amount of postnatal growth, as well as the greatest postnatal growth, also the greatest individual variation in its morphology.

Deep jaw growth

Like the nasomaxillary complex, the mandible grows forward and downward mainly as a result of the displacement of the entire bone. The mandibular symphysis part of the mandibular symphysis contributes little or nothing in length during postnatal growth (Figure 4.10).

Figure 4.10 Growth of the mandible



With the growth backward and upward of the condyle, the ramus relocates backward, apposition occurs at the posterior margin of the ramus with simultaneous resorption of the anterior contour, which lengthens the mandibular body.

The direction of growth of the condyle shows great individual variability, the range of growth appears to be greater in individuals with anterior range of growth appears to be greater in individuals with anterior growth of the condyle.

Jaw height growth

The growth in height allowed by the alveolar process to adjust the downward displacement of the mandibular body is downward displacement of the mandibular body depends on the direction and rate of growth of the direction and rate of growth of the condyle. In relation to the mandibular base, the amount of condylar growth averages 3mm during, of condylar growth averages 3mm during childhood and up to about 5mm during, 5mm during the pubertal growth spurt. The lower border of the mandible.

The lower border of the mandible contributes little to the growth in height, what occurs in this area is extensive remodeling (Figure 4.10).

- Growth in width.

Because of its early fusion, the symphysis has little involvement in postnatal width growth (V-shape). postnatal width growth (V-shape) As both branches have the same diverging V-shape in a vertical V-shape in a vertical section, the same principle of growth will contribute in width during the vertical enlargement of the coronoid processes (1, 4,11)

Figure 4.11 Direction of growth of the lower jaw

4.6 Stomatognathic apparatus

The stomatognathic apparatus (from the Greek *στόμα*, mouth; and *γνάθος*, jaws ---- Stoma-oral cavity and Gnatus-jaw) is a morphofunctional unit whose elements correlate with each other organs and tissues to develop the functions of the stomatognathic system which are: eating, speaking, pronouncing, chewing, swallowing, smiling, breathing, kissing or sucking therefore any pathology should be treated in relation to the overall health of the individual not individually (14).

Located in the craniofacial region, in an area bounded approximately by a frontal plane passing through the mastoid processes and two horizontal lines passing, the upper one through the infraorbital ridges and the lower one through the hyoid bone.

Knowledge of the anatomy and physiology of the elements that make up this stomatognathic system, also known as the masticatory apparatus or gnathic system, is the basis for defining the concepts of normality, pathogenesis, treatment and prevention of cervico-craniofacial diseases. This system has become the object of study of dentistry. (14)

The stomatognathic system is the integrated and coordinated morpho-functional unit, constituted by the set of skeletal, muscular, vascular, nervous, glandular and dental structures, organized around the occipito-atloid, atlo-axoid, vertebro-vertebral cervical, temporomandibular, dento-dental in occlusion and dento-alveolar joints, which are organically and functionally linked with the digestive, respiratory, phonological and aesthetic-facial expression systems and with the senses of taste, touch, balance and orientation to develop the functions of sucking, oral digestion (which includes chewing, salivation, tasting and initial degradation of carbohydrates), swallowing, verbal communication (which includes chewing, salivation, tasting and initial degradation of carbohydrates); swallowing, verbal communication (which is integrated, among other actions, by phonological modulation, articulation of sounds, speech, whistling and desire); oral sexuality (which includes smiling, laughing, oral-facial gesticulation, kissing, among other aesthetic-affective manifestations); alternate respiration and vital defense, integrated by coughing, expectoration, sneezing, yawning, sighing, exhalation and vomiting, essential for the survival of the individual. (14)

4.7 Components of the stomatognatic apparatus

Lips:

The lips are the entrance to the digestive tract and the anterior opening of the mouth. They have a central muscular portion, made of skeletal muscle, covered on the outside by skin and on the inside by a mucous membrane.

Salivary glands

They are the glands annexed to the mouth, formed by two groups main salivary glands such as the parotid, submaxillary and sublingual glands and accessory salivary glands such as the palatine, molar and labial glands, The function of these glands is the secretion of saliva 24 hours a day and varies between 1000 and 1500 milliliters and their functions are to maintain the humidity of the mucosa of the oral cavity to avoid its drying, to moisten the food to facilitate its chewing and swallowing by the dissolution of the substances, which allows to capture the taste of the same (15,16).

Braces

Frenulum are mucosal folds of fibrous connective tissue, muscle or both, that join two contiguous surfaces, and that in certain situations can cause orthodontic, phonetic, periodontal and prosthetic problems, due to variations in their shape, size and position. According to their location they are classified as: upper labial, lower labial and lingual. (14, 15,16).

Teeth

Del lat. *dens, dentis*, are hard structures formed of mineralized tissue that begin to develop from embryonic life, and begin to erupt in the first six months of life, articulated in the alveolar processes of the maxillary and mandibular bones through a special type of joint called gonphosis, attached to the bone by the periodontal ligament, involved in the functions of chewing food, digestion and also participates in oral communication. Basically in the tooth two parts can be recognized, the crown, part covered by dental enamel and the root not visible in a healthy mouth. (14)

The deciduous dentition consists of 20 teeth, whose appearance begins at approximately 6 months of age and their replacement by permanent teeth lasts until approximately 12 years of age.

The permanent dentition begins to erupt at approximately 6 years of age and will replace the teeth of the first dentition until adolescence. The permanent dentition consists of 32 teeth. At the age of 16 to 25 years the third molars (called "wisdom teeth or wisdom teeth") can erupt and are frequently retained in the jaws (14, 15, 16)

Gum

It is a fibromucosa formed by dense connective tissue with a covering of keratinized squamous epithelium that covers the alveolar processes and surrounds the teeth. The gingiva is contiguous with the periodontal ligament and, on the outside, with the mucosal tissues of the oral cavity.

Floor of the mouth

The floor of the mouth is limited by the lower dental arches, forming an elongated cavity called lingual canal where the tongue rests and we observe on the sides of the lingual frenulum the mouth of the main submaxillary and sublingual glands. (14, 15,16)

Cheeks

The cheek, cheeks or cheeks is each of the two prominences in the human face, below the eyes. It is also called the fleshy part of the face, from the cheekbones to below the jaw and next to the lips. (14, 15,16)

Palate

The palate is a structure that forms the roof of the oral cavity and separates it from the nostrils: it is covered by masticatory mucosa and is an area of friction whose interaction allows the tongue-palate to articulate sounds (14,15,16).

Tonsils

They are part of Waldeyer's lymphatic ring, are masses of lymphatic tissue masses of lymphatic tissue, located in the lateral walls of the isthmus of the fauces (throat).

Oropharynx

It is an anatomical region located in the most posterior part of the mouth, whose limits are from the soft palate to the hyoid bone and includes the posterior third of the tongue.

Maxilla

It is the most voluminous bone of the face, is even and forms part of the upper jaw is irregular quadrilateral shape, with two faces, internal and external, four edges and four angles.

Jaw

It is the only movable bone of the bony head, is odd and horseshoe-shaped and forms part of the temporomandibular joint.

Paranasal sinuses

They are pneumatic cavities that communicate with the nasal cavities and their function is to lighten the bone, humidify and warm the air and communicate with the nostrils.

Temporomandibular joint

It is a bicondylar joint formed by the condyle of the temporal bone and the anterior portion of the glenoid cavity of the temporal bone where the condyle of the lower jaw articulates, these surfaces are adapted by means of an articular disc, which, together with the masticatory, supra hyoid and infra hyoid muscles, allow the mandible to perform masticatory movements, such as opening and closing, protrusion, retrusion, and laterality. (14, 15,16)

Alveolar-dental articulation

It is the one that takes place between the dental pieces and the alveolar processes of the upper and lower jaw, its greatest importance is that it maintains a relationship of interdependence with the ATM: Any functional or pathological disorder of localization in any of them will be able to alter the integrity of their respective constituent elements. (14, 15,16)

Muscles

The muscles involved in the functioning of the stomatognathic apparatus are the following muscle groups: head muscles, masticatory muscles, and muscles of the anterior and lateral neck region;

Vascular system

Primitive carotid system, internal and external carotid, and subclavian artery. And the jugular system, formed by the internal jugular trunk, tributary trunks to the internal jugular and the venous sinuses of the dura mater.

Nervous system

Formed by the central and peripheral nervous system and the main nerves are the trigeminal, facial, glossopharyngeal, and greater hypoglossal nerves.

Lymph nodes

Lymph nodes are strategically distributed throughout the body and are an important part of the immune system. In the head they are distributed as follows: submental, submaxillary, anterior auricular, posterior auricular, occipital, superficial cervical, deep cervical and finally clavicular lymph nodes. They are accumulations of lymphatic tissue that act as the first line of defense of our organism helping it to recognize and fight microbes and infections. (14,15,16)

4.8 Physiology of the stomatognathic system

Its main functions are chewing, swallowing and phonation and it should not be forgotten that this system still influences facial expression, aesthetics and stabilization of the mandibular skull (Lee 1992).
During the functions of this system, the jaw assumes different postures and can be at rest, in occlusion or in movement.

4.9 Mastication

It is a conditioned, learned and automatic function necessary for the nutrition and digestion processes of the organism. It begins with tooth eruption and during which jaw movements are guided by specialized nerve receptors (proprioceptors) constituting a complex neuromuscular activity.

Chewing is directly influenced by dental occlusion, without which chewing would significantly decrease in efficiency. The maximum intercuspidation is reached about 5000 times a day during normal functions.

When chewing occurs in an alternating bilateral manner it results in the greatest occlusal stability.

When it occurs unilaterally, a compensatory adaptation is necessary through increased masticatory effort, which may lead to joint problems in the future.

The masticatory muscles produce a pressure of up to 200 - 300 Lb. (90-136 kg). The maximum functional masticatory force is 300 to 500 N in the molar region in an individual with healthy natural dentition.

When there is tooth loss, the periodontal ligament disappears, this leads to the absence of all its functions and perhaps the most important one is proprioception - sense of location, as a regulatory mechanism of the physiological masticatory force protecting the anatomical structures of the maximum anatomical force through the opening and closing reflex. (14)

Masticatory cycle

Constituted in the mandibular opening processes, then by the mandibular closing and finally by the occlusal phase.

There is a variation in the magnitude of the masticatory force in relation to the consistency of the food. Therefore, in a soft diet the movements are more vertical and there is less lateral displacement, while in a hard diet there is more lateral displacement.

* Factors influencing Functional Peak Masticatory Strength (F.M.M.F):

- Gender and age
- Feeding time
- State of the dentition number and position of teeth.
- Mandibular positions in the sagittal plane.
- Mandibular positions in the horizontal and frontal plane.

- Craniofacial Skeletal Characteristics is the most important one and refers to whether it is brachycephalic (more strength) or dolichocephalic.

Stages of chewing

Incision or prehension

It is performed through the anterior teeth with the contraction of the external pterygoid, infrahyoid and digastric muscles, as well as the levator, temporalis, masseter and internal pterygoid muscles.

Cutting and grinding

It is performed through the marginal ridges and cuspid elevations. During this stage it occurs with a bilateral mandibular movement with repeated cycles so that there is reduction of large pieces into small ones, resulting in an increase in the surface area, which is where the digestive enzymes work most efficiently.

Final movement

In this stage the most posterior parts are very important, through the occlusal faces of the molar units, which is where the food bolus is formed. This occlusal table helps the softening and transformation into a size conducive to swallowing for it is also necessary the correct lubrication of the food impregnating it with saliva. (14)

4.10 Deglution

It is a primary unconditioned reflex that occurs twice a minute. Unconsciously.

According to some authors up to 3 years of age it is accepted as normal that the child keeps the arches separated at the moment of swallowing, between 3 and 5 years of age the masticatory function is perfected and the swallowing function matures. In the adult it is characterized by tongue and lip interposition, the jaw is elevated and the teeth in dental occlusion, slight lip contact and no contraction of facial muscles.

In the functional analysis we must observe the lingual position. The tongue occupies most of the interior space of the mouth and provides an internal shape for the dental arch, therefore any modification in its function or position will be reflected in the shape of the dental arch. If the tongue is placed low or high in the vestibular sector, this will produce different forms of occlusion such as crossbite.

In the clinical examination the tongue should be observed at rest and during swallowing, its size should be analyzed, the presence of scalloping can be suspected of macroglossia. (14)

The size of the pharyngeal tonsils is important in swallowing, since tonsillar hypertrophy produces tongue protrusion.

Swallowing stages:

1. Buccal: Voluntary stage where the food bolus is formed.

2. Pharyngeal: Lasts from 1 to 2 sec. Elevation of the soft palate, closure of the epiglottis. It is characterized by elevation of the pharynx and hyoid and the passage of the alimentary bolus produces peristaltic stimuli.

3. Esophageal: lasts 5 - 8 seconds, a peristaltic wave is produced in the smooth muscles along the esophagus.

4.11 Fonation

The mouth forms the sounding board together with the nostrils, its annexes such as the paranasal sinuses and the pharynx. The stomatognathic system plays an important role especially for the pronunciation of interdental and labiodental phonemes. Intentional phonation is more complicated since it has to be performed on the basis of stabilized and learned pharyngeal and lingual jaw postures. Phonation is characteristic of Homo sapiens, while language is the exclusive capacity of man, through which he is able to communicate. (14,15)

There is a strong relationship between dentomaxillofacial anomalies and speech disorders. The most frequent being dyslalia caused by defective lingual frenulum.

4.12 Breathing

Normal breathing is through the nostrils. When there is obstruction of the nasal passage, air entry through the oral cavity is resolved, but at the cost of many other side effects: The immediate effects consist of the introduction of dry, dust-laden cold air into the mouth and pharynx. The warming, humidifying and filtering functions of the air entering through the nose are lost, with consequent increased irritation of the pharyngeal mucosa.

The long term effects are more complex and far reaching, from the moment the mouth is opened the tongue descends and loses contact with the upper jaw, which influences the growth of the upper jaw generally leading to maxillary compression, the tension of the muscles varies, producing a series of alterations in the muscular function that affects the posture of the lower jaw and the teeth as well as the postural muscular chain of the individual (14,15,16).

4.13 Aesthetics

The current aesthetic canons in our civilization are in accordance with the golden ratio or divine proportion. These principles or "requirements" of beauty are captured unconsciously by our sight. They could be considered as naturally immutable throughout the centuries in our human conception of beauty.

When we talk about aesthetics there must be harmony in the structures that we observe, that is to say a relationship of aesthetic balance without predominance of only one element, so we will talk about facial harmony with symmetry, all this follows under a parameter that has been called golden ratio.

In order to obtain ideal dental esthetics it is necessary to provide a harmonious, pleasant and balanced smile. For this reason it is necessary, in order to treat our patients bioesthetically, to perform an analysis of all the factors involved in the smile in order to properly diagnose the esthetic problem and determine the patient's concerns and expectations. (14)

Failures in dental esthetics can only be avoided if we pay due attention to the determining factors of harmony and proportionality, as well as the incorporation of the patient in the decision making process, under the guidance of the dentist, through the presentation of all the treatment alternatives.

The golden ratio. For many artists it represents the ultimate expression of Beauty, the perfect proportion, perhaps because we ourselves are built in golden proportions.

In the field of dentistry, it has been discovered that the dentition grows, following golden proportions, and so do other facial features, such as the smile with respect to the dental arch, the distance between the eyes and many more. The widths of the four front teeth, from the central incisor to the premolar, are in golden ratio to each other.

The ratio between the width of the smile arch and the width of the 8 central teeth (the ones that can be seen while smiling) is also golden. When the teeth are not together, the lip line divides the lower part of the face according to the golden ratio. The relationship between the distance between the eyes and the width of the eyes is also golden.

In physiology, a smile is a facial expression formed by flexing the muscles near the ends of the mouth, but also around the eyes. Studies have shown that smiling is a normal reaction to certain stimuli and is not learned, but born with it (14).

Smiling not only changes facial expression, but also causes the brain to produce endorphins that reduce physical and emotional pain and provide a sense of well-being. Smiling can be considered a soft, silent form of laughter Babies begin to laugh around four months of age.

Laughter is a part of human behavior controlled by the brain. It is used as a sign of belonging to a group (indicating acceptance and positive interactions). Laughter is contagious; often laughter itself causes others to laugh. This partly explains the popularity of canned laughter in TV comedy series.
Some medical theories attribute beneficial effects on health and well-being to laughter, since it releases endorphins (14).

4.14 References

1. Proffit, W. R., Fields, H. W., & Ackerman, J. L. (1994). *Ortodoncia: teoría y práctica: segunda edición*. Mosby/Doyma Libros.

2. Graber, T. M., Vanardsdall, R. L., Frydman, J., & Sosa Manrique, N. B. (1997). *Ortodoncia: principios generales y técnicas*.

3. Moyers, R. E., & LEYT, S. (1992). *Manual de ortodoncia*.

4. Enlow, D. H.: (2006) Crecimiento craneofacial; 3ra. Edición, México, Editorial Interamericana McGraw-Hill, 2006; 26-29; 35-37.

5. Farkas, L. G., & Munro, I. R. (Eds.). (1987). *Anthropometric facial proportions in medicine*. Charles C Thomas Pub Limited.

6. Ricketts, R. M., & Porter, R. J. (1983). *Técnica bioprogresiva de Ricketts*.

7. Mc. Namara JA. (1997). Un método cefalométrico. Evaluación. Am. J. Orthod,

8. Greulich WW, Pyle SI. (1959). Radiographic Atlas of Skeletal Development of the Hand and Wrist. 2nd ed... London: Oxford University Press.

9. Canut, J. A.: (2005). Ortodoncia clínica y preventiva; 2da. Edición, Barcelona-España, Editorial Masson S.A., 355-367.1.

10. Pritchard, J. J. (1956). The osteoblast. In the biochemistry and physiology of bone.

11. Lagman, S., & Sadler, T. W. (2005). Embriología Médica con orientación clínica. *Editorial médica panamericana sa 8va edición*, *357*.

12. Moss, M. L., & Salentijn, L. (1969). The primary role of functional matrices in facial growth. *American journal of orthodontics*, *55*(6), 566-577.

13. Scott, J. H. (1959). Further studies on the growth of the human face.

14. Zerón, A. (2003). *Cómo conservar sus dientes y encías toda la vida: odontología para pacientes*. UNAM.

15. Quiroz Gutiérrez, F. (1962). Anatomía humana. *Porrúa México*, 264-277.

16. Sinelnikov, R. D., & Tergas, H. V. (1976). *Atlas de anatomía humana: Estudio de los huesos, articulaciones, ligamentos y músculos*.