

## Philosophical study of growth and development orthodontics

### Studi filosofis tentang pertumbuhan dan perkembangan ortodontik

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#### ABSTRACT

A thorough knowledge of dentocraniofacial growth and development is necessary for every dentist. From philosophies stand point, the ontology of to comprehend condition observed understanding the growth and development processes that orthodontics. Meanwhile epistemology, methods of studying about growth and development in orthodontic treatment has progressed a lot. Axiologically, dentists and orthodontists are heavily involved in the development of not just the dentition but the entire dentofacial complex, a practitioner may be able to manipulate facial growth for the benefit of the patient and malocclusion treatment. It is not possible to do so without a thorough understanding of both the pattern of normal growth and the mechanism that underlie it.

**Keywords:** philosophy study, growth and development, orthodontic

#### ABSTRAK

Pengetahuan menyeluruh tentang pertumbuhan dan perkembangan dentokraniofasial diperlukan bagi setiap dokter gigi. Dari dasar filosofi, ontologi untuk memahami kondisi diamati memahami proses pertumbuhan dan perkembangan yang ortodontik. Sementara epistemologi, metode belajar tentang pertumbuhan dan perkembangan dalam pengobatan ortodontik telah berkembang banyak. Secara aksiologis, dokter gigi dan ortodontis sangat terlibat dalam pengembangan tidak hanya gigi tetapi seluruh kompleks dentofasial. Seorang praktisi mungkin dapat memanipulasi pertumbuhan wajah untuk kepentingan pasien dan pengobatan maloklusi. Tidak mungkin untuk melakukannya tanpa pemahaman menyeluruh tentang pola pertumbuhan normal dan mekanisme yang mendasarinya.

**Kata kunci:** studi filsafat, pertumbuhan dan perkembangan, ortodontik

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#### INTRODUCTION

The term philosophy is derived from a Greek word “philosophia”. As times evolved, it was also known in various languages, such as “philosophic”. Philosophy is a comprehensive science that seeks to understand the problems that arise in the overall scope of human experience. Scientists, especially the currently renowned ones such as Plato, Aristotle, Galileo, Pythagoras, Archimedes, etc., developed a mindset based on logic to uncover secrets of nature one after another. The Greek thinkers successfully developed philosophy by observing objects in the sky on a regular basis; they paid attention to how orderly those objects moved when they rise and set. Thus, Plato, Socrates, and Aristotle’s philosophy were developed.<sup>1,2</sup>

Dentists are frequently questioned by parents regarding how their children’s teeth are going to grow. In order to answer those questions, competence to predict how the situation is going to turn out after seeing the condition during the early period of growth and development is necessary. The terms growth and development can cause difficulties in understanding between the two. Although are closely related, growth and

development are not identical. On the other hand, if growth is only defined solely as the process of change, then the terms will mean almost nothing. Growth commonly refers to an increase in size and number of cells, weight, and intracellular matrix mass size but sometimes the increase is not only limited to number or size but also complexity. Growth is largely an anatomic phenomenon, whilst development is a more physiological and behavioral phenomenon. It must be remembered that although dentists work on the physical appearance of the teeth and face, the main reason for orthodontic treatment is its psychosocial effects. In addition, collaboration with the patient is necessary and it is important to know how to gain knowledge regarding social and behavioral development of children in various ages, both physiological and psychosocial development are equally important.<sup>3-5</sup>

Humanity’s effort to get a good arrangement of teeth can be traced back to 3000 B.C., where an orthodontic appliance to move teeth that aren’t in their normal positions were found in Egypt. The same effort can be found in several places with different sets of evidences. However, what is considered a stub towards or-

thodontics, as we know it today began in 1723 when Pierre Fauchard from France made bandolet to arrange the teeth. Afterwards, in 1850 Norman W. Kingsley from USA wrote oral deformities, which contains etiology, diagnosis, and treatment of dental position abnormalities. His article became the basis of modern orthodontic and he emphasized the importance of learning biology also growth and development that causes malocclusion. Orthodontic as one of the oldest specializations in dentistry begins from the end of 20<sup>th</sup> century, orthodontics was initially interpreted as a branch of dental science that paid attention genetic variation, facial growth and various factors that affect dental occlusion and the function of various related organs. In other words, orthodontics is everything related to growth, development and function of all orofacial complexes.<sup>6,7</sup>

## PHILOSOPHICAL REVIEW

### Ontology

Ontology is derived from Greek words, *on* means being and *logos* means logic. Hence, ontology is the theory of being qua being or theory about existence as beings (Feibleman). Ontology is the oldest standing philosophy, which comes from Ancient Greek, and discusses the existence of something concrete. Ontology is the basis of all science that seeks to answer the "what", which according to Aristotle is the first philosophy, and is the science of the essence of matter. Ontology talks about a reality, a reality faced by humans (researchers, doctors, scientists, etc.) and those realities are very concrete. Reality means various phenomena that are physical or empirical in nature and all of it exists around humans and the reality then leads to truth.<sup>1,2,8</sup>

The process of growth and development is a complex life phenomenon and is a normal biological phenomenon of living beings, taking place since prenatal from conception to birth, followed by postnatal period starting from neonates till adulthood. Dentocraniofacial growth and development include the growth and development of occlusion, dental arch, also upper and lower jaw related to craniofacial growth. Todd defined growth as the increase of size, according to Krogman growth is the increase of size, changes in proportion and progressive complexity. According to Moyers, growth is all one-way changes that occurs naturally in an individual life's from its existence as a single cell organism all the way to a multifunctional unit and until death.<sup>3,7,9-11</sup>

Growth as the increase of physical size of cell, organ tissue or organism as whole, alongside with differentiation and changes in the shape of living things is a change that occurs as a function of time, which includes modification in physical size, form, or position of a structure. Besides undergoing changes in shape, growth

also includes a constant relation in all separate parts and each part of the regional component. The purpose is to maintain and reach overall functional and structural balance through growth and adjustments in accordance with various other parts, both adjacent and far apart. Therefore, growth in one region, both local and interdependent parts, there exists a mutual linkage to achieve a balanced state. For example, the width of interorbital and nasomaxillary complex bordering the cranial base, the growth determinant of each part is a combination of genetic, epigenetic or soft tissue factors in the region.<sup>3,12-14</sup>

Development is a natural progression where an increase of function complexity occurs gradually or step by step in order to achieve the stage of maturation. Organism maturities are associated with changes in functions from simple to complex including biological aspects, physiological abilities, motoric as well as sensory skills. The development process takes place to achieve a state of structural aggregate and functional equilibrium. For this reason, a series of changes occurs from the embryo at the prenatal stage to the postnatal stage, which continues to the maturation stage as an adult and lasts throughout life or from its origin as a single cell to death.<sup>3,7,10</sup>

Although growth and development are two different processes, but neither one stands alone and both are intertwining process. Both aspects are sometimes hard to be distinguished and separated so they are put together into growth and development, which means changes in maturities including size and quality. The basic principle of growth and development takes place continuously, is a complex process but follows certain rules in a certain order and rhythm of individual growth. Growth and development are processes those can be predicted; observation of growth and development can be done systematically and efforts can be made to maximize the potential for growth and development of each child. For that reason, it is necessary to evaluate the growth and development of children using standard norms according to their race.<sup>3,9,11</sup>

A broader understanding of orthodontics according to the American Board of Orthodontics (ABO) is a specific branch in dentistry that is responsible for the study and supervision of the growth and development of teeth and related anatomical structures, from birth to adulthood, including preventive and corrective actions for irregularity in the location of teeth, which requires the repositioning of teeth with functional and mechanical appliances to reach normal occlusion and good facial structure. Orthodontic treatment involves bone growth manipulations and dental corrections. Orthodontic clinicians are required to have an extensive understanding regarding dental development and the concept of

physical growth.<sup>6,9,10,15</sup>

Included in this definition is the problem of growth and development in a broad sense, namely the growth and development of teeth until they reach permanent tooth phase occlusion and the growth and development of jaw and face, in the context of orthodontics growth and development are incorporated in one specialization. Growth and development are highly related with orthodontic and need to be studied because malocclusion isn't a disease but a deviation in growth and development. Deviations in growth and development of teeth positions can cause malocclusion, e.g. crowding of teeth. Deviations in jaw growth and development could cause skeletal deformities for example Class III Angle malocclusion marked by forward mandibular position with respect to maxilla. Irregular teeth positions and jaw position deformities have a big impact on individual's appearance. Most orthodontic abnormalities affect an individual's psychosocial rather than their physical health.<sup>6,12</sup>

### Epistemology

Epistemology is derived from Greek word episteme meaning "knowledge", "the right knowledge", "scientific knowledge", and logos means theory. Epistemology is a study about knowledge, how to know things. This knowledge seeks to answer questions such as how humans obtain and capture knowledge and types of knowledge. According to epistemology, every knowledge human possesses are the results of examination and investigation of objects until it was finally known to humans. Rahmat *et al.*, affirmed that epistemology is a branch of philosophy that investigates the origin, nature, methods, and limits of human knowledge.<sup>1,2</sup>

The pattern in growth represents proportionality, but in a more complex way, because it refers not only to a series of proportional relationships at a point in time, but also to changes in proportional relations over time. The embryonic period at the beginning of 21 days after fertilization, when the human embryo is more than 3 mm long, is when head begins to form. During the fetal life, about 3 months intra uterine, the heads take up almost 50% of the body. In this stage, cranium is larger than facial structure and takes up almost half of the total size of head. On the contrary, the limbs are still not perfect and the trunk is not yet developed. At birth, the trunk and limbs have grown faster than the head and face, so the proportion of the whole body devoted to the head has decreased to around 30%.<sup>4,7</sup>

An important concept in the study of growth and development does varied, because everyone is not the same in their growth. It may be difficult but clinically it is very important to decide whether an individual is in the normal or abnormal range. Rather than categori-

zing growth as normal and abnormal, it is more important to think in terms of deviations from the usual pattern and to express variability in a quantitative way. There are two main approaches to study growth.<sup>6,9</sup>

The measurement approach includes techniques for measuring certain criteria in animals or skeletal remains. These techniques are not invasive. Most human growth studies are carried out using measurement techniques can be used on living individuals or skeletons namely craniometry, anthropometry, cephalometric radiography and 3-dimensional imaging.

The first measurement approach used to study growth with physical anthropology science begins with craniometry, based on skull measurements found among human skeletal remains, which is the art of measuring skulls to find their specific differences. Craniometry involves measurement of human skulls from various age groups to determine changes in growth. Craniometry was originally used to study Neanderthals and Cro-Magnons whose skulls were found in European caves in the 18<sup>th</sup> and 19<sup>th</sup> centuries. From these skeletal materials, it is possible to gather a great deal of knowledge about extinct populations to get an idea of their growth patterns by comparing one skull to another. The advantage of craniometry is that rather precise measurements can be made on a dry skull.<sup>4,9,10</sup>

The dimensions of skulls can also be measured in living individuals by anthropometry technique; various landmarks set out in the study of dry skulls are measured in living individuals using soft tissue points. For example, measuring the length of the cranium from the tip of the nose to the largest convex point behind the skull. This measurement can be done on a dry skull or a living individual, but the results will differ due to the thickness of the soft tissue covering the landmarks. Although soft tissue rises the variations, anthropometry makes it possible to follow individual growth directly, making the same measurements repeatedly at different times. The best data of that type comes from 20<sup>th</sup> century studies, which provide valuable recent data on the proportion of human faces and their changes, evaluating human growth from conception, infancy, and childhood to adolescence then adult life.<sup>4,9,10,16</sup>

The third technique is cephalometric radiology, of highly importance not only in the study of growth but also in the clinical evaluation of orthodontic patients. This technique has contributed greatly to the researches on growth and development before it became a routine practice to use cephalograms for orthodontic diagnosis and planning. This technique depends on the proper head orientation before making a radiograph, with the exact magnification control. This approach can combine the benefits of craniometry and anthropometry. This allows direct measurement of the dimensions of

the skeleton, because bone can be seen through soft tissue covering in the radiograph, but also allows the same individual to be followed up from time to time. The disadvantage of cephalometric radiography is that it produces a 2-dimensional (2D) representation of a 3-dimensional (3D) structure, and even with precise head position, not all measurements are possible. To some extent it can now be overcome by using more than one radiography in different orientations and using triangulation to calculate slanted distances. The general pattern of craniofacial growth is known from craniometric and anthropometric studies before cephalometric radiography was discovered; many recent images of craniofacial growth are based on cephalometric studies.<sup>4,9,13</sup>

The fourth technique is being obtained by applying 3-D imaging techniques. Cone beam computed tomography (CBCT) machine is a radiographic device that produces informative images and description of craniofacial structures, including the anatomical structure of the patient's oral cavity, face, and jaw. Computed axial tomography (CAT) or more commonly known as computed tomography (CT), allows 3-D reconstruction of cranium and face and this method has been applied in the last 30 years to plan surgical treatment for patients with facial defects. Recently, CBCT from axial CT has been applied to head and facial scans, this significantly reduces radiation dosage and costs. The CBCT allows scanning of patients with radiation exposure that is much closer to the position of the cephalogram, superimposition of 3-D images is much more difficult than superimposition using 2-D cephalometric radiography, but methods have been developed to overcome this difficulty.<sup>4,17</sup>

The fifth is analysis of measurement data. Both anthropometric and cephalometric data can be expressed cross-sectioned rather than longitudinally. Obviously it would be much easier and faster to conduct cross-sectional studies, collecting data once for each individual and including subjects of various ages, rather than spending years on studies where the same individual was measured repeatedly. Fluctuations in growth curves that might occur for almost every individual will be seen in cross-sectional studies only if they occur at the same time for every individual. Longitudinal studies are efficient in the sense that much information can be obtained from a small number of subjects, less than the amount needed in cross-sectional studies. In addition, longitudinal data highlights individual variations, especially variations caused by the effect of time. Measurement data can be presented graphically in number of different ways and often, it is possible to clarify changes in growth by varying the display method. Various other mathematical transformations can be used

with growth data to make it easier to understand.<sup>4</sup>

The second approach is experimental approach. This approach includes techniques that may be manipulative and invasive so that they can endanger animals. This method is performed on experimental animals for experimental growth including vital staining, radioisotopes, autoradiography, and implant radiography.

The vital staining method is an experimental method for managing growth. Much has been learned about skeletal growth using vital staining technique; in which were dyes applied to mineralized tissue (or sometimes soft tissue) were injected into animals. These dyes remain in the bones and teeth and can be detected after death. An English anatomist, John Hunter created this method in the 18<sup>th</sup> century. Hunter observed that pigs that were often fed with textile waste often had interesting stains on their bones. He found that the active substance was a dye called alizarin, which was still used for vital staining researches. Alizarin reacts strongly with bone calcium. Because this is an active skeletal growth site, the dye marks the location where active growth occurs. Although research using vital staining is not possible in humans, vital staining can occur accidentally. Many children born in the late 1950s and early 1960s were treated for recurrent infections with tetracycline antibiotics. It was found that tetracycline is an excellent vital stain that binds to calcium at the growth site in the same way as alizarin. The incisor discoloration resulting from tetracycline given during the mineralization process of teeth has become an aesthetic disaster for some individuals.<sup>4,9,10</sup>

The second, radioactive elements can be injected into animal tissue that is inserted into developing bone. Growth can be studied by tracking radioactivity emitted by the radioisotope through the emission of isotope energy, for example calcium 45, technetium 33 (Ca 45, Tc 33).<sup>9,18</sup>

Another experimental method that can be done to study human physical growth is implant radiography. In this technique, a metal pin is inserted into any bone in the skeleton, including the face and jaw. This metal pin is well tolerated by the skeleton, permanently inserted into the bone without causing problems, and easily visualized on a cephalogram. If the pin is placed in the jaw, a fairly accurate increase in longitudinal cephalometric analysis of the growth pattern can be achieved. The method was developed by Arne Bjork and colleagues at the Royal Dental College in Copenhagen, Denmark and is widely used by workers there. This provides important new information about jaw growth. With 21<sup>st</sup> century technology, proper evaluation of dentofacial growth in humans using implant cephalograms has largely been replaced by 3-D imaging using CT or

MRI, but it can still help to use implants to provide landmarks for superimposition. By checking the position of these implants on serial radiographs that taken regularly, bone growth can be monitored. Information such as growth location, growth rate, and direction of growth can be obtained accurately using implant radiography.<sup>4,9,10</sup>

The results of the current advancement of research are more research related with growth such as growth factor hormones and morphogenetic proteins are being done. With rapid advances in molecular genetics, this provides a large amount of new information about growth and development and how to control it.<sup>3</sup>

## AXIOLOGY

Axiology is derived from *axios* a Greek word meaning *value* and *logos*, which means theory. So, axiology is a field of study that investigates values. Values and implications of axiology in education are education that tests and integrates all values (the value of moral action, the value of the expression of beauty and the value of sociopolitical life) in human life. Axiological approach tries to give a plus or minus, useful or not useful, beneficial or detrimental to each topic that is highlighted. Axiological studies are extremely important for the people, organizations, institutions and individuals involved.<sup>1,2</sup>

Growth and development are complex 3-D process, which lasts until the late teens and then some in a small number continues in adulthood. Growth refers to an increase in tissue size as result of hypertrophy or a combination of these factors. On the other hand, development refers to the rise in organization and network specialization, qualitative and quantitative changes and the acquisition of various competencies to function optimally in the social environment.<sup>11,19</sup>

The dentocraniofacial growth and development study is a specific orientation that emphasizes growth analysis for diagnostic purposes, determining treatment plans and prognosis of malocclusion and dentofacial deformity that are found to require understanding of the process and mechanism of growth and development. In all studies growth and development is very important for orthodontists because it helps to diagnose and assess cases and plan the best treatment plan for patients.<sup>2,13,15,20</sup>

Every dentist needs to understand craniofacial growth and development, understand the growth and development of teeth and its supporting bone structures maxilla and mandible. This relates to the competence to detect, diagnose and conduct prevention and treatment of malocclusion also dentofacial deformities, all these requires understanding of the characteristics at each stage of growth and changes that occur in

the period of growth and development. Malocclusion is a deviation of normal skeletal growth and development, and teeth and related anatomical structures, which can disrupt a person's psychological condition. Deviations in skeletal growth and development have a significant effect on occlusion that occurs in the upper jaw and the lower jaw.<sup>3,6,21</sup>

Knowledge of normal human growth and development enables dentists to recognize abnormal or pathological growth. Representative population growth studies provide standardized data on development. The doctors need the norm or standard for height, weight, skeleton and tooth development to assess the normality of growth in patients. Understanding the principles and complexity of craniofacial growth and development is very important for dentists because timely recognition and intervention of abnormal jaw growth patterns by proper orthodontic appliances can restore normal occlusion and facial harmony using active growth period. Growth and development have important roles for orthodontic science in determining the ideal treatment time in cases of malocclusion. There are three types of biological age or physiological age based on growth and development of bones (skeletal age), teeth (dental age), and sexual development (sexual age). Biological age determination can inform and assist in diagnosing, treatment plans and determining orthodontic treatment times. Growth and development do not occur at one time or simultaneously, but there are certain periods where there is a slowdown and acceleration of growth (*growth spurt*). Data regarding *growth spurt* may assist the orthodontist in determining a treatment plan particularly appropriate the initial time of orthodontic treatment. The entry time of the growth spurt period can be determined by predicting maturation stages accurately and appropriately. The growth spurt period can be determined by predicting maturation stages accurately and appropriately. Each case of malocclusion has a different ideal orthodontic treatment time.<sup>9,22-24</sup>

The understanding of normal growth and development is of great importance for orthodontists due to several reasons, namely understanding the etiology of malocclusion, recognizing abnormal growth patterns and the ability to know the right treatment time also comprehension of the factors that affect the stability of treatment and orthodontic treatment seeks to maximize the effectiveness of anatomical compensation to achieve a harmonized esthetic and mastication system.<sup>19,25</sup>

The period of orthodontic treatment can begin from infancy to adulthood and is an inseparable treatment. As in patients with cleft lip and palate, orthodontic treatment is needed from infancy to adulthood. Most orthodontic patients need treatment since the first four upper and lower incisors have erupted until they can

be seen that whether there is a malocclusion. Orthodontic treatments are not only limited until patients reach adulthood but elderly patients can also benefit from orthodontic treatments.<sup>6,13</sup>

From the discussion, it was concluded that a thorough understanding about growth and development particularly dentocraniofacial growth and development is vital for conducting orthodontic treatments.

The importance of the knowledge about growth and development incorporated in the process of treatment planning and during treatment has gained more recognition. Philosophical study has been very helpful and has become the basis of knowledge from the emergence of knowledge and the conception of methods to study growth and development, which has become the reference in orthodontic treatment.

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