Dentofacial Orthopedics in the Growing Child

Understanding Craniofacial Growth in the Management of Malocclusions

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Introduction

This book is the result of 40 years' experience treating malocclusions, which affect two-thirds of the child population. What has changed in 40 years? Growth and development have not changed, but today, we understand more how each dentofacial structure contributes to correct the problems the clinician sees on a daily basis. We are still amazed to see how early prevention and interception yield excellent long-term results that nature works in our favor when we work with it.

In dentistry and in many other fields, we deal with symptoms: "What" the patient has and "how" we are going to deal with the problem? A cavity? How are we going to fix it? An infection? How are we going to handle it?

Orthodontic Objective

The objective of phase 2 orthodontics treats factually the consequences of a malocclusion following specific particular mechanical, concrete, and measurable targets in shortest time.

Why can't we treat early if the problem can be diagnosed early?

It is said by some: "No matter what you do in the early management of malocclusion, the patient will end up with braces or clear aligners. So why invest now if you will pay again later?"

Class I Malocclusions

Some clinicians say, "Let us wait. We have the means to have all teeth within the arches. We have the leeway space; we can expand, we can do some stripping and, if needed, extract some permanent teeth."

Class II Malocclusions

Some clinicians say, "Let us wait because we know we have two growth peaks in the mandible. If the mandible does not respond, we have the means to push the maxillary molars back, create space for all teeth, and reduce the overjet." Alternatively, extracting the first premolars facilitates the anterior segment's retraction, improving the horizontal overbite regardless of the patient's profile.

Class III Malocclusions

Still, some clinicians state, "There is nothing we can do because the problem is genetic."

For many, it is easier to deal with sequela because occlusal consequences can be treated.

This attitude prevents asking hard questions: Why this happened? When did it start? How I can work with nature to resolve a potential problem? What I can expect because I understand growth and development?

Orthopedic Goals

Contrary to orthodontic objectives, orthopedics aims at early diagnosis of a potential or actual malocclusion, to prevent or intercept this condition assisting nature to allow growth deficiencies to resume and attain its maximum standard class I potential.

Treating young children with orthopedics demands that we ask these questions but most importantly to have answers:

*Who is my patient?
*Why did this clinical condition occur?
*When did it start?

*How did it manifest itself?
*How can we intercept it?
*When should we start?
*What will happen if I wait?
*What can we expect to happen when we start working?

These questions require looking back at the growing child because answers to most of these questions can be found in the primary or early mixed dentitions. The whys are more important than the hows.

Appliances, when needed, only become the instrument to obtain expected results and allow nature to return to the predicted genetic class I normocclusion. Today we can answer these questions with acquired knowledge.

Simplification Versus Complexity

When we do not understand craniofacial growth and development, i.e. biology, genetics, and environment (nature and nurture), we tend to use our short-term logic without foreseeing long-term problems and consequences.

For example:

Serial extractions for crowding situations.

We do not ask questions regarding how extractions will affect the facial profile of the patient and the alteration of his/her craniofacial growth. We do not attend to if the patient is a horizontal or vertical grower. We do not pay attention to social phobias of patients, who as a result of too many extractions in the early stage of life, nor potential TMJ problems, or creating poor esthetic facial characteristics that might have an impact on the future of patients. We are only interested in today's problems such as resolving a crowded situation.

Our academic preparation and thinking method continue to be reductionist and separatist that tries to disaggregate complexity into small parts to make this problem more manageable and understandable.

The reductive/analytic disjunctive thinking approach of what the patient has and how I will fix it today cannot give an adequate understanding of complex, interconnected phenomena. We cannot isolate these occurrences from their environment and operate with the disjunctive logic of either/or.

This separation confines one side of the equation, leaving us in half obscurity, shrinking all possibilities to obtain a reasoned result. It is like thinking that other parts of the body do not exist. We cannot keep living in the comfort of waiting until craniofacial growth is almost complete to start treatment. We cannot keep a blind eye to what craniofacial growth is. We cannot wait and see how the face and dentition deteriorate and deal with the sequel, affecting the patient's future, well-being, quality of life, esthetics, and occlusion.

Logic does not always mean success. For example, extracting teeth in a class I malocclusion when there is no space – bringing the maxilla or permanent molars back in class II malocclusion to fit the well-positioned maxillary bone to the small mandible – or in class III malocclusion, placing a chin cup to stop the mandible from growing, when the main problem is a small maxilla. We need to learn that we cannot go against natural growth and development. This makes up the human endowment. We cannot overlook the integral wisdom of evolution and ignore the whys.

Why Can FOUR Appliances Correct Most of the Malocclusions?

Why can the same appliance with its modifications correct class I, class II, and class III malocclusions? Why does nature maintain a crowded class I in a class I patient after expansion? Why does a class II patient with the same appliance turn into a class I? Why does nature in environmental class II regain a class I growth pattern? Why does a genetic class II, when overcorrected reaching a class III molar relationship, return passively to a class I after the appliance is removed? Why does an overcorrected class III into a class II regain a class I relationship? Why for nature class I is the expected goal?

Dentofacial orthopedics will prevent, inhibit, and redirect potential deviations from the balance that should exist between genetics and the environment without forgetting all the bio–psychosocial and cultural issues that makes us unique. Dentofacial orthopedics predicts the outcome when we place an appliance. When we understand craniofacial growth, we can intercept and redirect, alter most malocclusions when we make a good diagnosis and communication exists with children and parents.

How will few appliances deal with a myriad of problems affecting children?

We will see in this book that possibly 90% of children have genetic class I normocclusions, but deteriorate into different malocclusions due to diverse environmental factors. 65% of class I malocclusions are environmental. Of the 35% of class II malocclusions possibly only 5% to 7% might have a genetic origin, most of which can be corrected. From the average 5% genetic or environmental class III malocclusions, only 2% might display genetic mandibular

skeletal protrusions, where dentofacial orthopedics has a limited correction potential.

For this reason, with early prevention or interception, 90% reorient passively toward a class I normocclusion.

Appliances only help to restore the normal craniofacial growth once we detect a malocclusion developing. The earlier we start once patient cooperation is established, the faster results, the best prognosis will be achieved.

Orthopedics can correct early lateral shifts and prevent facial asymmetries from temporomandibular dysfunctions, which are seen more often in youngsters. It will initiate function when congenital problems, trauma, fractures affect the joints.

In this book, we tried to show the most common problems clinicians will face. We suggest starting with the simplest case, gaining experience and confidence, and then adventure into more complex ones. Starting with a complex case guarantees to become the first and last case.

Pay attention to each case and the figures within the text because we add extra relevant information.

This book will guide clinicians to identify and diagnose problems and correction, exemplifying them with clinical cases.

We will see on several occasions throughout the book the exact phrases repeated to stress their importance.

Read the challenging questions and answers that follow most cases. They will hopefully clarify many of your doubts.

Analyze each case and long-term results carefully to understand how we can intercept a problem and allow nature to resume its normal growth.

This is the objective of this book!

Marc Saadia and Roberto Valencia

Acknowledgements

This book was written during the Covid-19 Pandemic and up to date this microscopic virus maintains its unhealthy dynamism and tenacity holding humanity confined.

During this time, both Dr. Valencia and myself had to work at a distance, never meeting in person. There was no need, because we both spoke most of the time the same language and other times when we disagreed, we had to do research with no truce to find out who was right and the winner of the discussion.

The process of this book, was a very enjoyable experience and every time we gained time to render it to the publisher, we always looked to update the information, insert new information and cases.

We now understand the phrase used for art "Art is never finished, merely abandoned." The same happens with novels and scientific books.

Networks are vital, because we are only a drop of water part of a great ocean. To write this book needed several ingredients:

Family empathy is essential because they have to endure hours and hours of self-centeredness and egoistic isolation.

This book is dedicated to our families who compelled us to be better and serve as an example for the future generations.

Betina, Vico, Eli, Liz, Michelle, Danielle, Ella, Marion, Camille, Lara, and Olivia.

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I have to acknowledge my long-time friend and co-author of this book, for the long hours we spent year after year, searching, inventing, using our logic to solve problems, becoming experts in other areas. It was always learning experience for me.

Thank you Roberto. Thank you Marc

Each case blends, the trust families place upon us to deliver a solution to their most valuable assets: Their children, and children helped us reach our predicted outcome.

Our friends and colleagues who contributed and enhanced this book. We learn a great deal from all of you.

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And last but not least, all the nameless persons we will forget to mention and placed their grain of sand to make our book possible. Our sole intention, is to share with all of you a little bit of our knowledge.

Marc and Roberto

1

Evolving Concepts in the Understanding and Treatment of Malocclusions

The fascinating growth phenomenon of the facial skull complex remains a mystery. However, it can be simplistically described as changes in proportion, elongation, or widening of skeletal and facial features and the addition to profile differences. These kinds of descriptions indeed have meaning, derived from observation and appreciation that part of every human's growth and development is appraised.

An artist can draw facial features showing bone/muscle balance characteristics and up to the skin. Likewise, a clinician seeks to improve the possible features of patients under treatment, believing that they can go to the bottom of the bone structures beyond the external manifestations.

The Growth and Facial Development student should be interested in how this growth occurs and what tissues and cells contribute. We must be able to differentiate between normal and abnormal growth and understand that we can correct certain problems depending on when we start treatment and expect complications when we do not consider environment and genetics.

The presentation form of this book/atlas intends to endow interested readers with an understanding of methodologies and their implications, predicting the growth differently but in line with the clinical practice.

The extraordinary diversity of features that characterize human beings have always been a source of intrigue and marvel. Pliny the Elder (Gayo Plinio 77a.C), in his Natural History Book, pointed out that, although the human facial countenance was composed of only "ten parts or a little more," people were molded in such a way that "among thousands, there were no two alike," "nor do they remain immutable throughout their lives."

From birth to death, human physiognomy is in a perpetual state of transformation. How do we explain this rich diversity of each of us both physically and psycho-socially, adding our cultural diversity? The most spectacular and notorious attempts to find the answer have been the simplistic theories known as genetic determinism and behaviorism. According to genetic determinism, all differences in form and function of people are ultimately due to differences in their genes. According to behaviorism, cognitive differences are merely learned responses to repeated stimuli. Nevertheless, the truth is more complex and even more spectacular.

Researchers can understand that each part of a puzzle, for example, an atom, can exist in isolation from its environment, thus knowing its function and interaction; they could build the whole puzzle and predict the system's future as a whole.

If this system works for physics and mathematics, can this same framework be reproduced on biological forms? Can we go back to square one? Certainly not; what we had a second ago will not be the same two minutes later.

> No man ever steps in the same river twice, for it's not the same river, and he's not the same man.
>
> – Heraclitus

An orthodontist, for example, is concerned to achieve a class I occlusion with or without extractions by any means after growth is almost complete. His questions center around what the patient has and how he is going to correct it. He is faced with the aftereffect when most malocclusions started as early as the primary dentition or early mixed dentition and could have been dealt with and reversed at that time with the possibility many times to achieve occlusal balance, esthetics, and functional goals. It is reasonable to speculate how events or failures of a biological condition treated late by mechanical means can affect an individual's bio-psychosocial well-being. (Diagram 1.1).

Dentofacial Orthopedics in the Growing Child: Understanding Craniofacial Growth in the Management of Malocclusions, First Edition. Marc Saadia and Roberto Valencia.

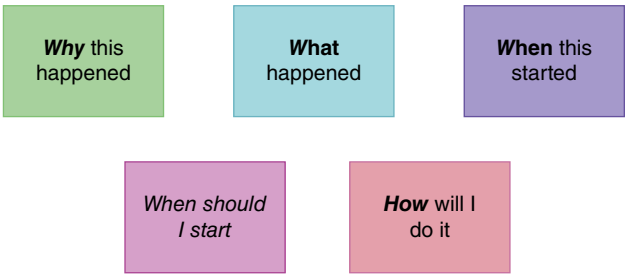


Diagram 1.1 By understanding the growth and facial development, the clinician should be able to answer these questions.

When Parents Do Not Want Extractions

This 13-year-old crowded patient presented with a slight convex profile. At this age when growth is almost complete, we needed to start extractions because of the bi-protrusive facial profile and maxillary crowding. Parents rejected the possibility of extraction. Placing the responsibility on parents, we expanded the maxillary arch and phase 2 orthodontic treatment; parents saw that the facial characteristics did not improve and accepted premolar extractions (Figures 1.1–1.6).

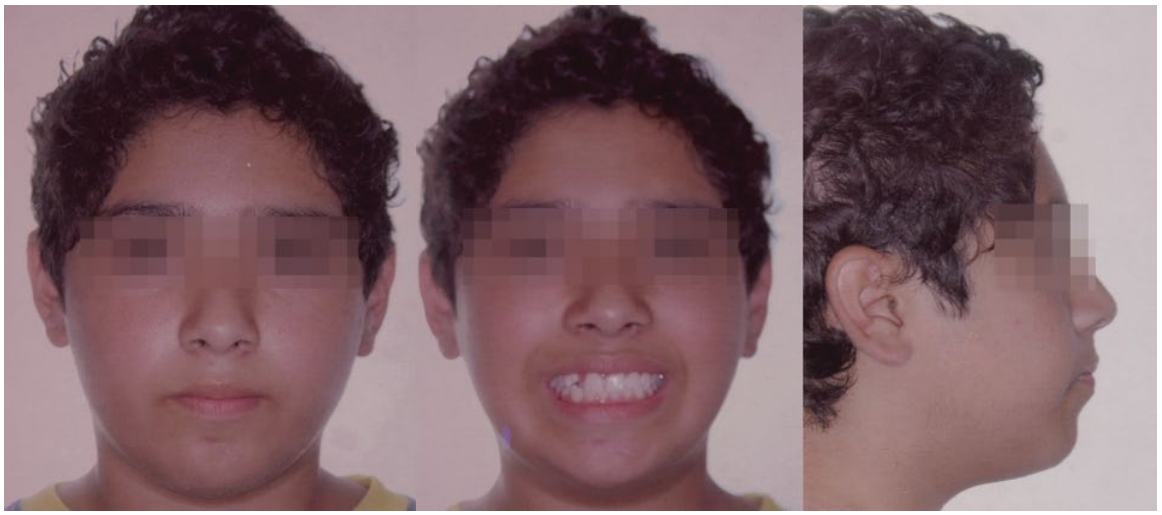


Figure 1.1 Extraoral photographs of an asymmetric smile of a 13-year-old patient, with a slight convex profile and retrognathic chin.

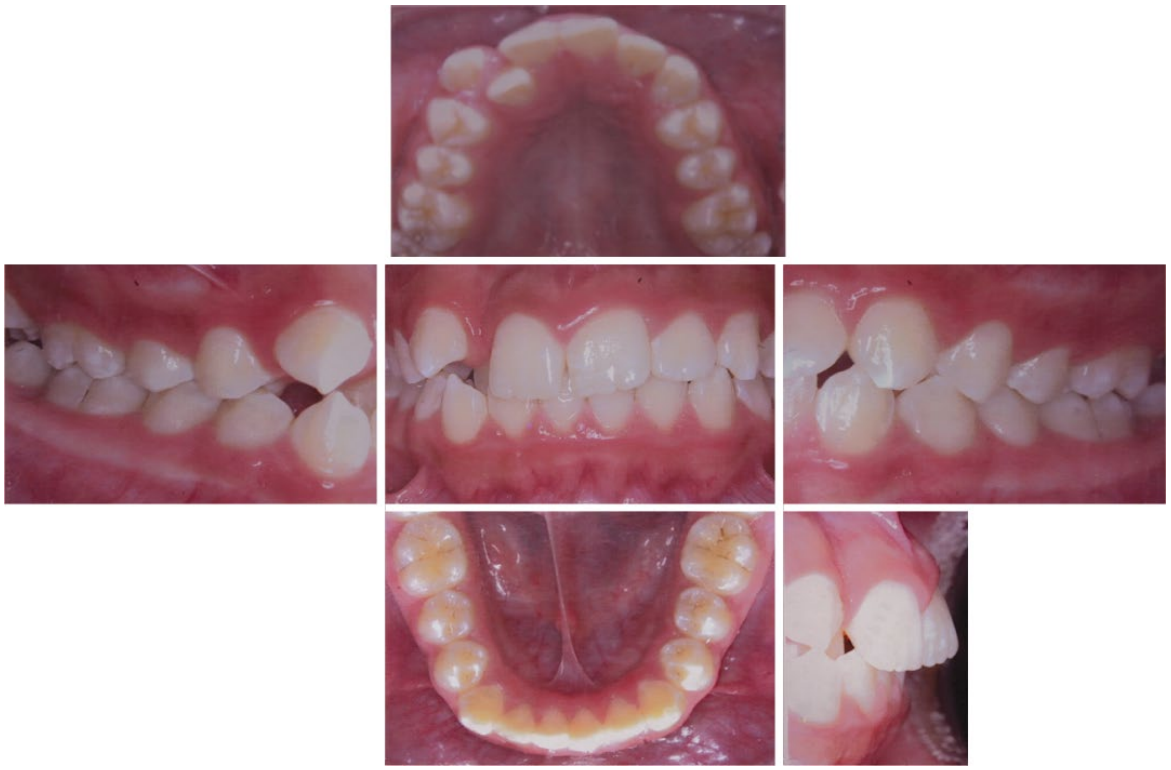


Figure 1.2 Intraoral photographs of the same patient with significant dental crowding in the maxillary arch, with the right lateral incisor, blocked in a palatal position.

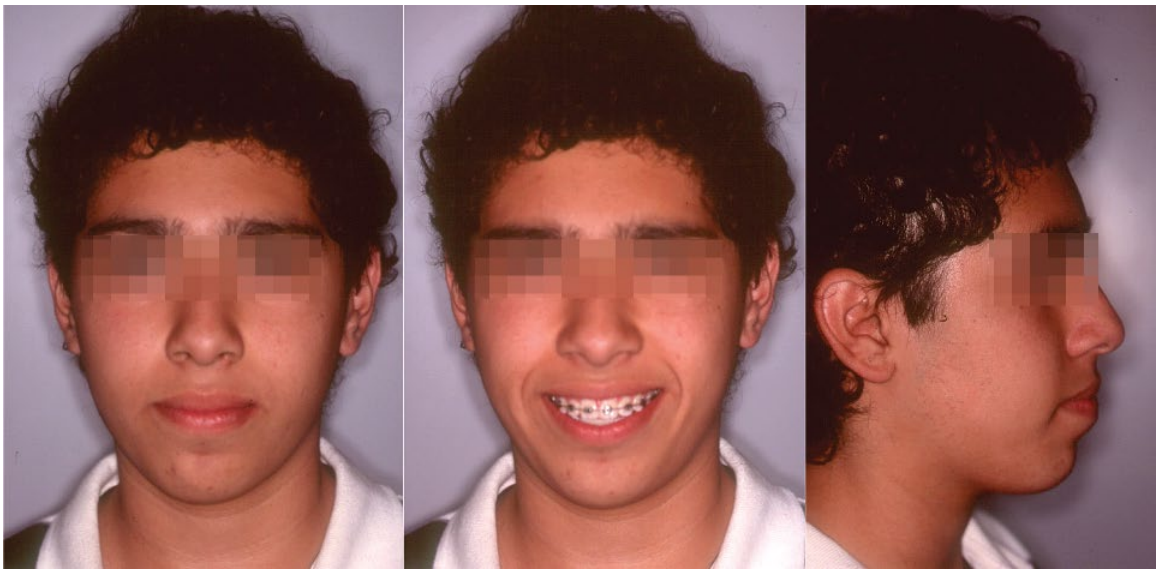


Figure 1.3 Extraoral photographs of the patient nine months after expansion and alignment treatment with brackets. We note a bi-protrusive profile maintaining the class I molar and cuspid relationship.

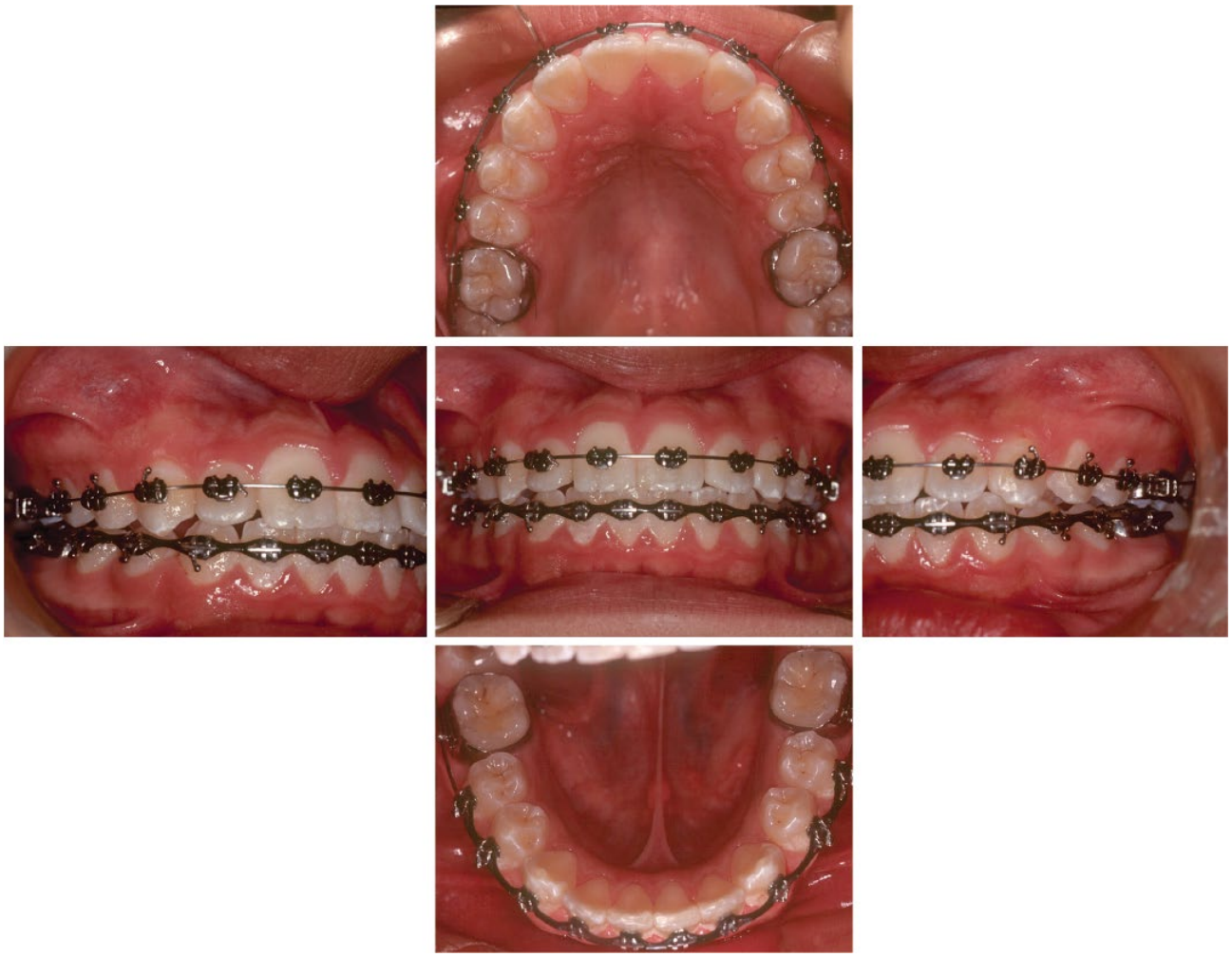


Figure 1.4 Intraoral photographs of the patient nine months after expansion and orthodontic treatment, with a class I molar and cuspid relationship. Even if occlusion was acceptable, facial characteristics deteriorated.

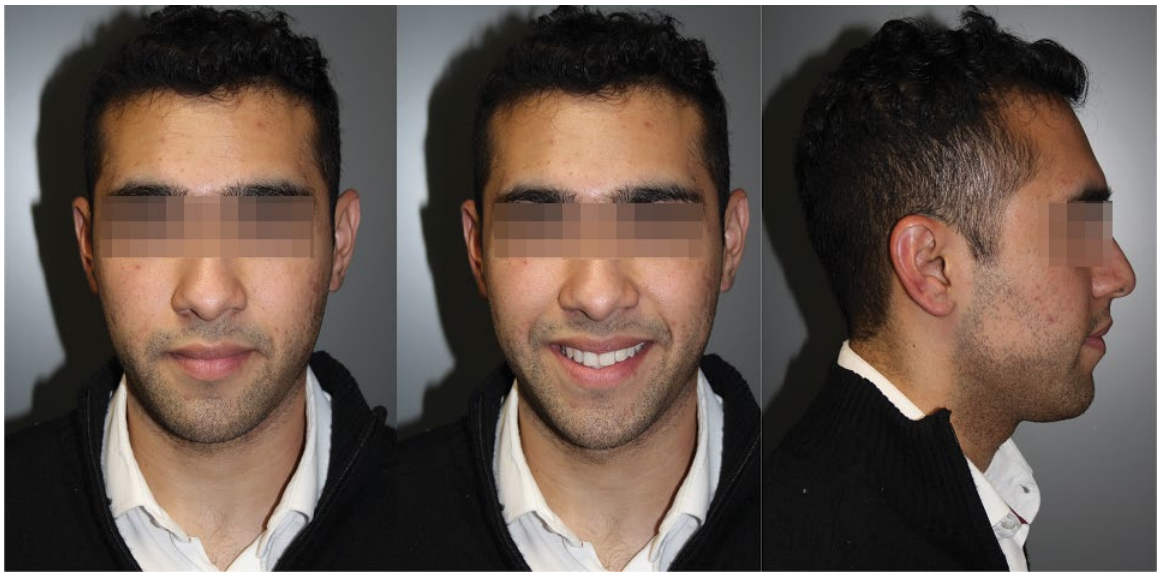


Figure 1.5 Extraoral photographs of the patient 10 years after initial treatment and four bicuspid extractions with a symmetric and well-balanced facial profile.

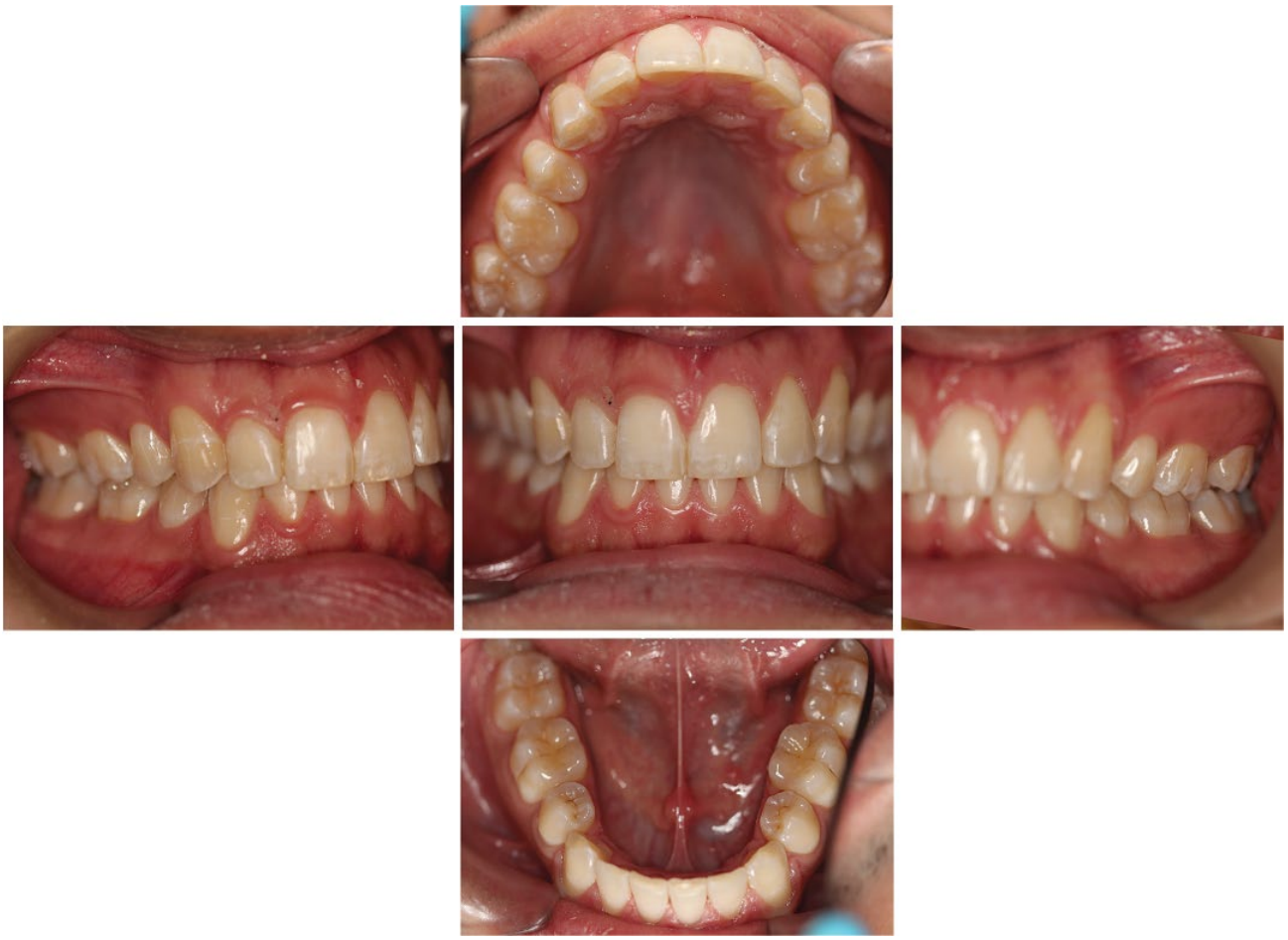


Figure 1.6 Intraoral photographs of the patient 10 years after initial treatment showing well-balanced occlusion without relapse.

From our perspective, this would be a final unacceptable profile if the parent brought her daughter for treatment. What profile do we prefer? Before or after with four premolar extractions? Maybe, extraction We do not know the dental and skeletal conditions or the patient's psychological, cultural, and social conditions conditions (Figure 1.7).

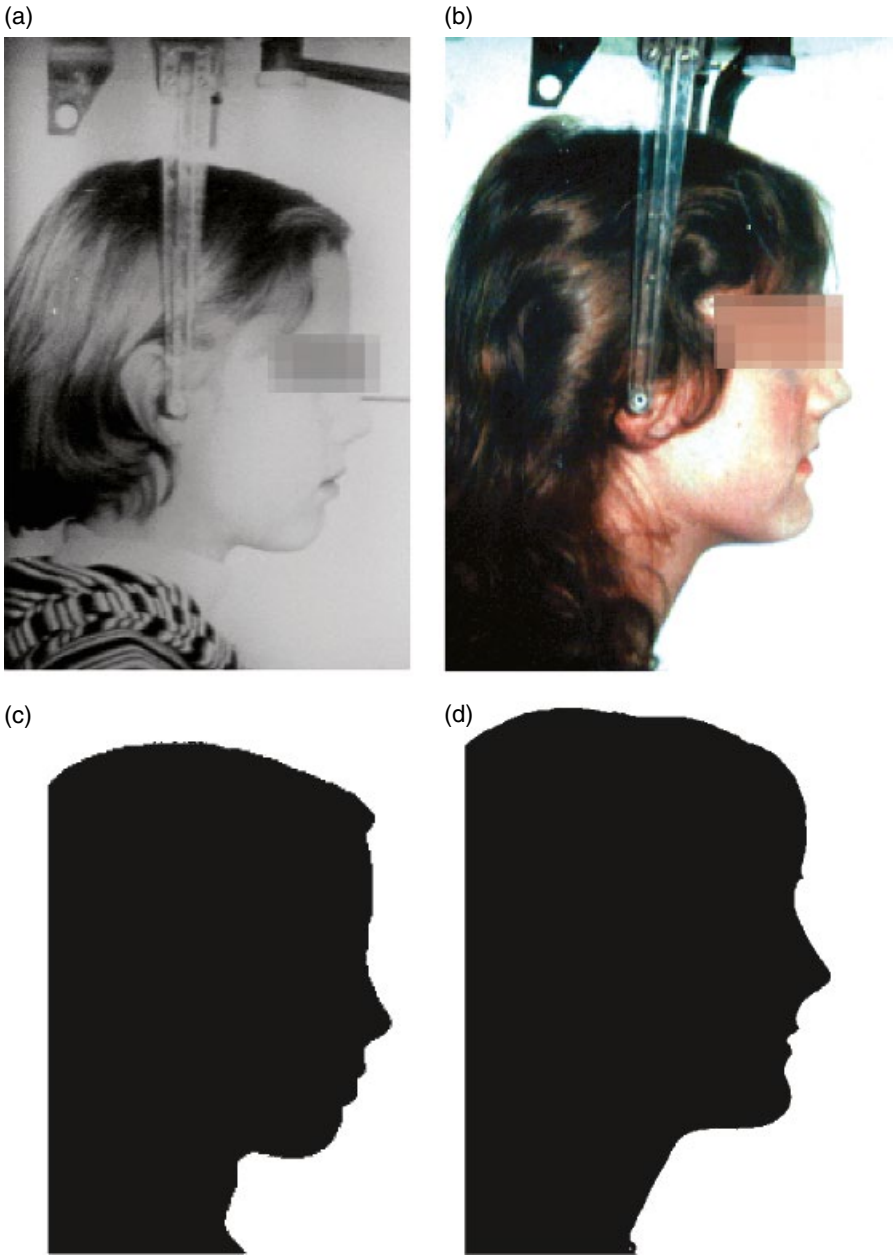


Figure 1.7 Patient in early mixed dentition with an acceptable facial profile (a–c); final unacceptable profile after four premolar extraction treatment (b–d).

Sometimes extractions will be needed to obtain a more balanced face, as in this case. Bi-protrusive faces in young children are usual and they tend to flatten out as children grow. Therefore, it is better to wait and observe how the face develops. A full set of occlusal and facial photographs should be taken to follow the patient's facial changes because we will not remember how they looked and will not be able to compare (Figure 1.8).

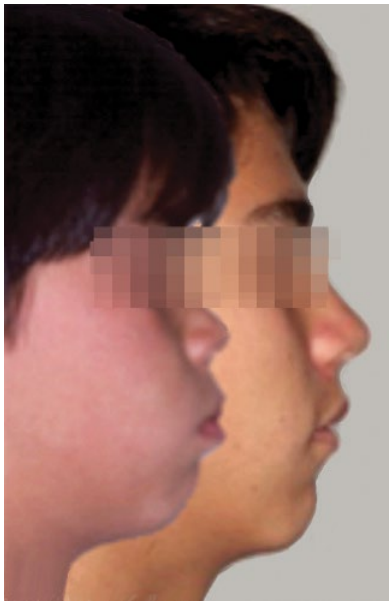


Figure 1.8 Patient before and after premolar extractions, obtaining a balanced face.

Today, before starting treatment, we need to predict what we are trying to achieve. In the past, teeth and good occlusion were the goals without considering possible consequences of four premolar extractions on our clients' future facial balance (Figure 1.8).

We need to remember that the first physical contact is the face, and "how" people look at us, the impact we make on them, better or worse, we grow and feel. It affects their psychosocial and cultural behaviors. A good-looking, personable person with high self-esteem may have access to a better university, relationship, job, and future. However, nowadays, people with tattoos, athletic, piercings, and dyed hair are found attractive. Society's interests tend to change all times, but facial and balanced esthetics have survived the history of time (see Chapter 8).

In the past, treatment started in general when most or all the permanent teeth were present in the mouth *(red dot in Waddington's landscape)*, not paying attention if the patient had a class I, II, or III (Figure 1.9) (Huang 2011). Treatment was designed to obtain the best occlusion. A class I molar occlusion was the goal. We also found new definitions to explain acceptable molar occlusions when this was not possible: Super class I, when the patient has a class III tendency, or a functional class II when the patient is a class II (Figure 1.10).

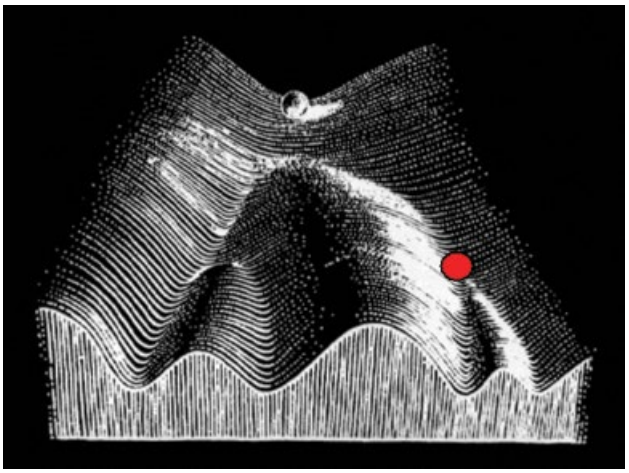


Figure 1.9 Waddington's metaphoric epigenetic landscape representing the unequivocal correspondence (unique mapping) between genome and the associated network architecture and the epigenetic landscape. In this case, a class I, II, or III could have been detected in the primary or early mixed dentitions (black ball on top). These malocclusions could have been intercepted early, allowing the craniofacial growth to resume normal class I growth, as we will see in this book. Observing the case deteriorate over time will only get us to the point (red dot) to decide, for example, whether to extract or not, or fix the occlusion without the possibility of altering the poor facial characteristics.

Figure 1.10 This cartoon represents the tailor making a custom suit. The logic would be to take measurements and create a new suit, instead, he wanted to cut hands and legs to fit his small suits. Alternatively, we could use the saying "When the only tool we own is a hammer, every problem begins to resemble a nail."

In Orthodontics

What-**How** (simplistic)

What the patient has and how I will correct it. Today, even with more tools in the field, the philosophy stays the same (Figure 1.11).

In Orthopedics

If ⟹ then

What will happen if . . . prevention- interception (If I do this---then**)**, what would happen, what we can expect . . .

Treating young children is a great challenge. Different malocclusions account for 70% of the population. We will have many times to decide early whether to take the left or right path (red dot). Most of the time, the crossroad we take might not be reversible, with skeletal, dental, and/or facial consequences (Figure 1.12).

Figure 1.11 There are several tracks, and most of them are blocked by genetic and/or environmental factors. Some of these obstructions could be removed early, offering more trails to move around and achieve the best treatment goals. Waiting, after growth has almost been completed, leaves few alternatives.

Who is my patient? **How** old is the patient? **What** the patient has? **WHY** this happened? **When** it started? Can we intercept this problem? (e.g. thumb sucking), or **What** needs first to be referred (airway)? Will it work if we remove the cause and allow the body to react and then treat? (the younger, the better). Do we need to treat? **When** can we start? – **How** will we intercept it? What can we expect? (Diagram 1.1, Figure 1.13).

What are we seeing? (i) Where can this malocclusion lead to? (ii) What can happen if we observe its development? (iii) Can we wait? (iv) If we need to start later, will we still have time to obtain the desired results?

Our patients and our questions are like traffic lights. Early diagnosis requires an arduous, demanding thought process, but very stimulating. We can make the best decision after analyzing hit-and-miss possibilities. When we observe positive changes (comparing with previous photographs), we will feel a breathtaking moment. When the treatment is completed and the predicted good results are observed, it will become an exciting experience, with which we will narrow treatment possibilities for all our patients (Figures 1.11–1.14).

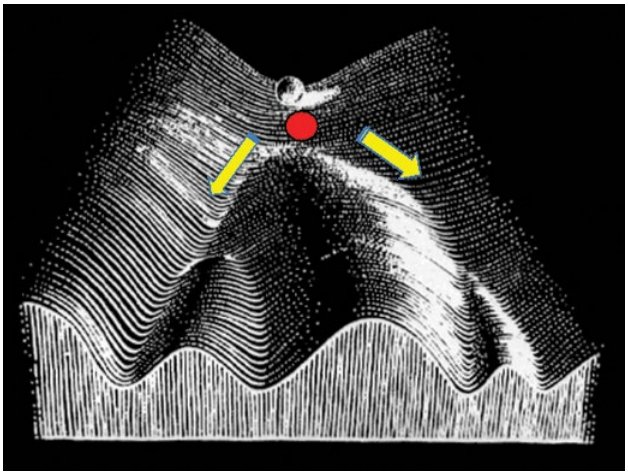


Figure 1.12 Waddington's metaphoric epigenetic landscape represents that many times the crossroad we take is not reversible, and unlike the railway station with predetermined routes, in orthopedics the path can take several pathways.

(a) (b)

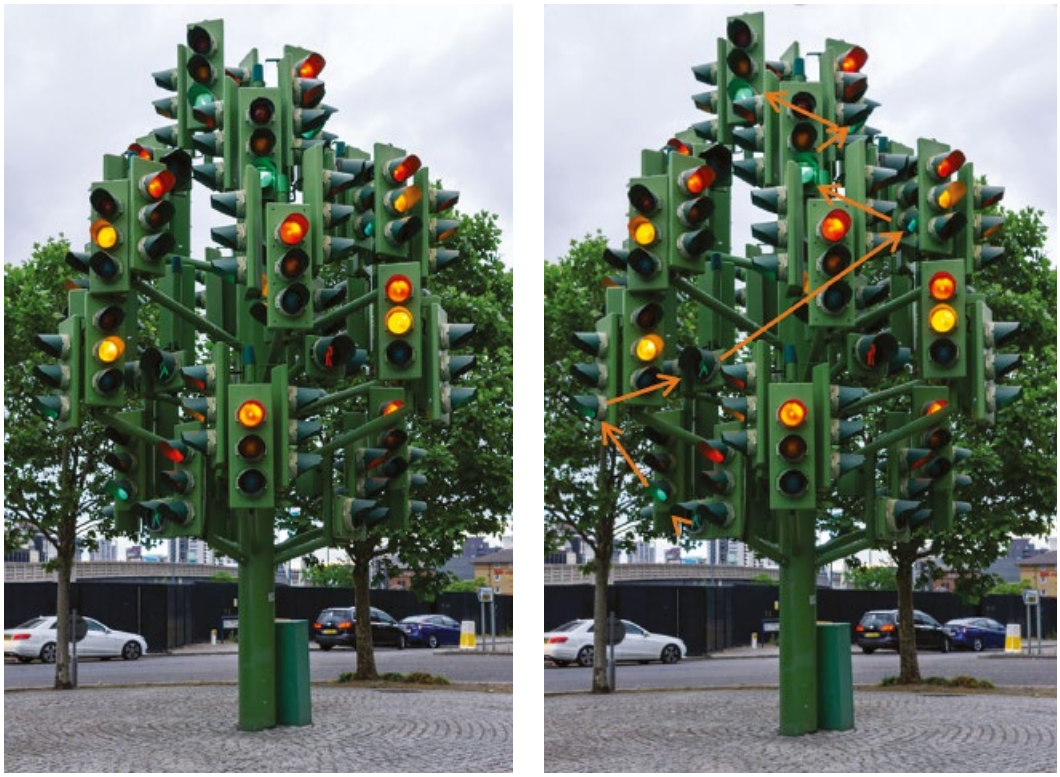


Figure 1.13 (a) It becomes more complex if we put together Waddington's epigenetic landscape (Figure 1.12) in this tree light. In orthopedics, several questions need to be answered before we can start treatment. When we understand craniofacial growth, we can put together all the necessary elements to accomplish the best treatment plan. Our thought process kicks in, bringing together all the elements that need to be considered: Age, cooperation, occlusion, malocclusion, facial characteristics, skeletal growth, tendencies, environment, genetics, growth prediction. We also need to paste growth and development to each of these factors. Let us start at the bottom of this tree light. In most cases, in orthopedics, building a treatment plan might take us to several impasses marked by red lights until we arrive at the green light at the top left side. (b) Once all the questions are answered, we will start to build our treatment plan from there up until we reach the summit green light. With experience, we will be able to predict faster what we can expect to accomplish. *By S. Hinakawa – Own work, CC BY-SA 4.0,* https://commons.wikimedia.org/w/index.php?curid=90950805.

(a) (b)

Figure 1.14 (a) Most of the time, we start phase 2 orthodontic treatment, with the remnants of malocclusion, which could have been resolved, mitigated, or facilitated its correction with all the ideal facial occlusal characteristics. At this stage, when almost no growth remains, our treatment options become limited, and we need to compromise, such as in this figure, in the boulevard, the right lane is permanently closed, and we can only go forward or turn left. (b) If we could have prevented or mitigated a problem and no treatment was done for any reason, we do not want to reach this dead end when no good options remain, and treatment outcome can be compromised.

The diagnosis and treatment plan of a growing patient is like a crude story of a cardiac surgeon who takes his car to fix the engine. The auto mechanic tells him: "I can fix car engines (second-phase orthodontics) just like you fix human hearts." Surgeon answers: "The difference is that I fix my patients with the engine running" (first-phase orthopedics).

The treatment of a child's growth and facial development requires a diagnosis according to age, gender, and race, which can be ambiguous because the comparison standards are based on a particular type of population. However, it may be possible to use some longitudinal growth and development studies to compare through templates such as Bolton, Burlington, or Ann Arbor studies.

First, we need to understand growth and development in children and that every skeletal structure within the system is interwoven in a vital continuous process. We cannot use cephalometric measurements from adolescent studies to establish goals on our treatment expectations because mostly they will mislead us. Logic and lack of knowledge sometimes can be counterproductive such as the examples we will present in different chapters of the book (Figure 1.15).

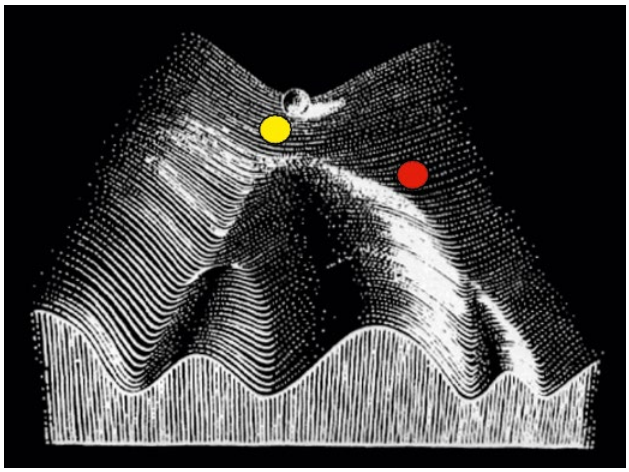


Figure 1.15 When we follow the craniofacial growth and development of a young child from the white dot and see that the growth path (yellow dot) is not the expected one, we can always change its direction (red dot). However, most interesting, we can always redirect and change courses when needed, because the growth is still active.

The Meccano Model

In the 1970s, understanding of craniofacial growth and development was based on a minimalistic and simplistic growth model called "counterpart." "If a structure increases its own size, what influence would it have on other neighboring structures, both in direction and in displacement in its three dimensions." This is a two-dimensional mechanized approach, leaving unresolved the main biological questions on **How**, **When**, and **Where** growth occurs.

If a given increment is added to a specific bone, where should an equivalent increment be added to other bones to maintain form and balance?

This question identifies which other specific bones or parts of bones might be involved as counterparts. So, the counterpart (as a mechanical model) solved only one of the questions and partially answered the process of craniofacial growth and development in only two planes (sagittal and vertical). This presented us with a naive idea of understanding growth, where each bar and screw had a specific function to describe the growth length and direction (Figure 1.16).

Is craniofacial growth a mechanical and two-dimensional structure? Or a four-dimensional space–time complex? dynamic, vibrant, lively, and tightly interwoven network formed by a set of structures that grow, displace, remodel, affecting its own structure and influencing, directly and indirectly, all components of the craniofacial complex? (Figure 1.16).

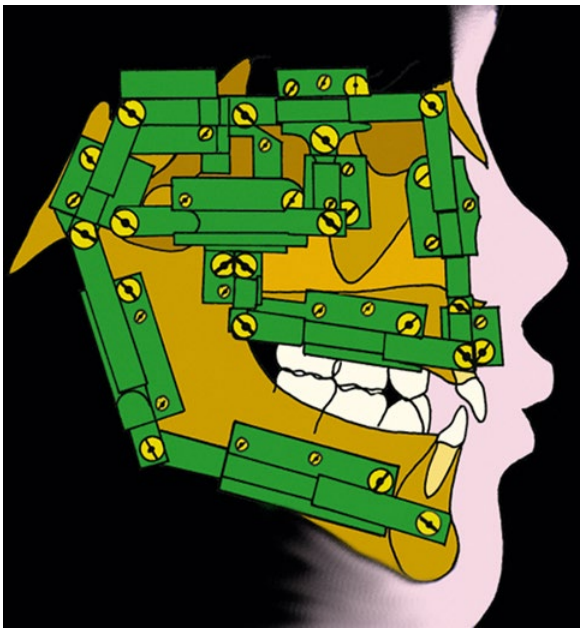


Figure 1.16 The Meccano model from the 1970s. This two-dimensional model made up of flat and curved metal pieces drilled and joined by round nuts and bolts exemplifies a human skull dividing all its components (today's Lego pieces). Each metal piece maintains a position and angle with the bordering one and, in turn, influences others.

The Biological Model

Understanding of craniofacial growth lies in perceiving all its different structures. Each of them presents different shapes that interweave and affect, directly and indirectly, the others. Finally, its total growth in its three dimensions plus time adds the fourth dimension and constantly influences them (Figure 1.17).

Harmonious and balanced growth is the consequence of three imperative factors: Neurosensory induction (neural inductor), growth potential (mesenchymal effector), and muscular balance (muscular activity).

These factors act on different craniofacial components of the Skull, Cranial Base, Nasomaxillary Complex, Mandible, and Dentoalveolar Complex (Manlove 2020).

The bone unit provides a typical example of the interaction between the genetic program's impact and the influence of functional habits. In this exciting statement, both the form and the result of growth need a partner force generated by a dynamic activity that depends on proprioceptive information. Form and function rely upon a compromise between the innate and the acquired, although their participation is unevenly divided mainly during the craniofacial complex growth.

The result of genes, combined with the environmental influence(s) called phenotype, constantly affects the bones, teeth, and occlusion.

The phenotype in vertical growers may interact, further intensifying the deleterious growth response. Its influence largely affects the lower part of the face. In

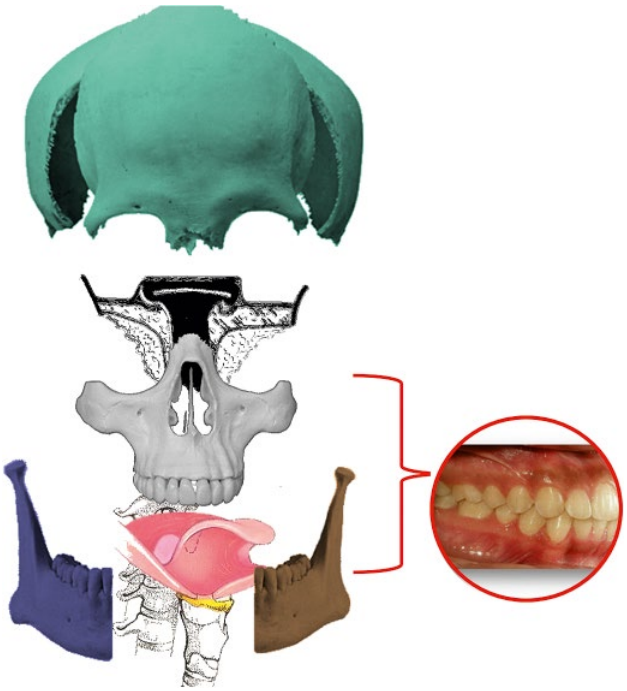


Figure 1.17 The biological model is more complex than the mechanical one. Considering all their different parts and counterparts, each initiates and/or responds and influences, directly or indirectly, the neighboring ones. This model also seeks to respond to growth forms, growth times, and the importance of growth sites from a biological perspective.

children, this can generate a facial growth pattern that resembles an adult profile.

Most of the cases with this phenotype will present a class III malocclusion caused mainly by a mandibular skeletal protrusion and a vertical growth. Imagine how a case may develop if no early treatment is performed; it will become a surgical case. At this age, we can attempt to intercept or mitigate its impact. Nevertheless, first, we need to find why the patient is developing this class III. Is it genetic?

In most cases, parents and/or grandparents pass these genes. However, in this case, an environmental factor is the cause, looking at the adenoid hypertrophy and lingual tonsil blocking the upper airway. Allergies could be the cause. To allow air to pass, the patient to "survive" needs to protrude the mandible to open the airway, activating mandibular growth and class III.

Adenoid tissue and lingual tonsil are lymphoid follicles that mediate B- and T-cell lymphocytes, forming part of our immune system generating hypertrophic adenoid tissues and lingual tonsils, both blocking the airway passage (Figure 1.18).

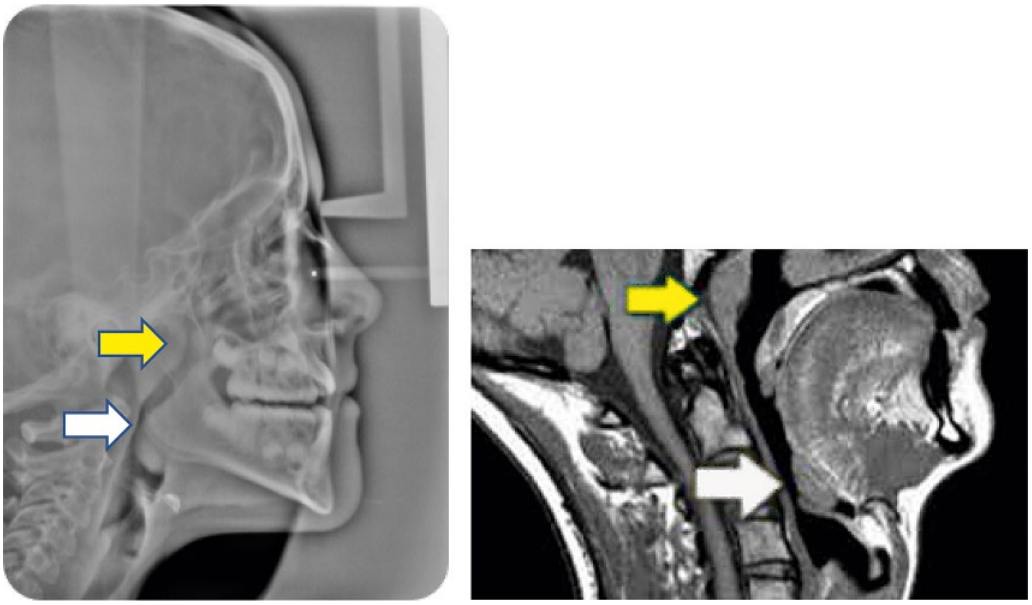


Figure 1.18 Cephalogram and 3D lateral section from a seven-year-old child with enlarged adenoid tissue (yellow arrow) and lingual tonsil (white arrow) blocking the airway passage. Observe how this young child presents a strong adult facial profile and how the patient is not occluding. This is a common phenomenon in mouth-breathing children who cannot keep their mouth closed in order to get air through their mouth. Additionally, mouth breathers in order to increase their posterior airway passage must bring the mandible forward, promoting class III skeletal malocclusions (see Chapter 11).

Orthopedic and Orthodontic Intervention Times

Health professionals working with newborns and children play a fundamental part in preventing or intercepting orthopedic problems. Clinicians, inexperienced about growth, suggest that both orthopedic and orthodontic efforts are insignificant and unnecessary for an early phase 1 treatment because its management and complications can be dealt with after growth is complete. We wonder if growth is fundamental at the level of other health specialties, why would it be different with the craniofacial complex. When we carry out these changes expeditiously and effectively, we know that it will lead us to establish a better balance and stability and shorter second phases if needed (Diagram 1.2).

The development of normocclusion with a Genetic and Environmental balance, from conception to the end of craniofacial growth, shows a balanced face, occlusion, stability, and TMJ health.

Having a balance between Genetics and Environment in the process of Growth and Development of the Facial Cranial Complex will lead us to an infrequent but ideal occlusion (Normocclusion). These infrequent occlusions are stable and functional and do not require any second phase treatment. When we perform treatments for any malocclusion, we will seek to have stability between the genetic factors, where we can only direct and reorient the growth, and the harmful environment as soon as it occurs; and it is possible to eliminate it (Diagram 1.3).

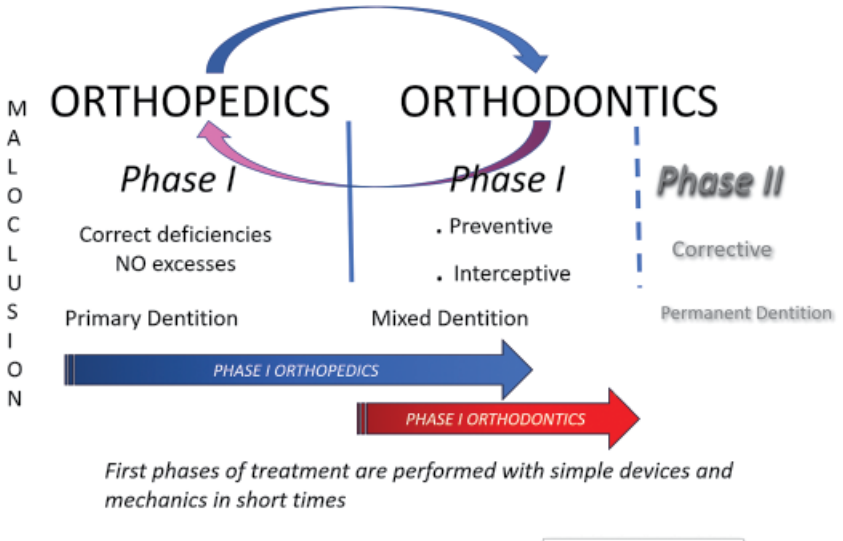


Diagram 1.2 Understanding the time and role of malocclusion treatment on Orthopedics and Orthodontics according to the type of dentition (primary, mixed, and permanent). They are divided into phase 1 (Orthopedic and Preventive and Interceptive Orthodontic) and phase 2 (Corrective).

During intrauterine development in normal circumstances (non-syndromic), a child will develop and come to life regulated by genetics. Some environmental circumstances can alter fetus development, such as fetal position, poor nutrition, stress, smallpox.

After birth, growth and development is mostly controlled by genetic factors but will be altered, enhanced, or restricted by environmental influences (e.g. use of forceps during delivery, habits). Its impact is felt mainly during active growth.

Fixing the remnants of a malocclusion with orthodontics when most of the growth has been completed has failed to explain how we deal with malocclusions. We need to understand that we are structured individually in a hierarchy of a physical, chemical, and biological revolving maze, which interacts permanently with social, psychological, and cultural influences, all of which are tightly interwoven.

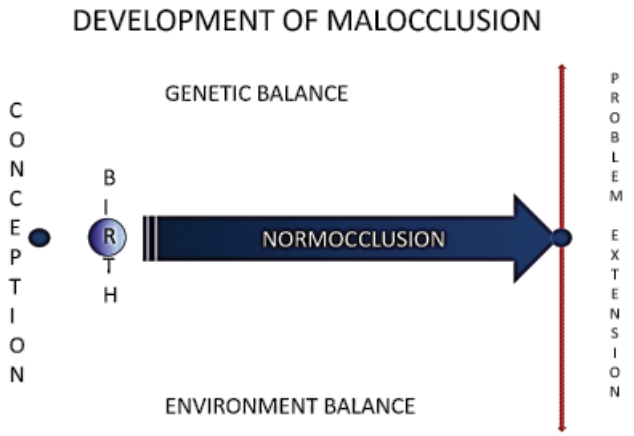


Diagram 1.3 The development of normocclusion with a Genetic and Environmental balance, from conception to the end of craniofacial growth, will exhibit a balanced face, occlusion, stability, and a healthy temporomandibular joint.

Genetics and Environment

When we think about the human race, we are overpowered to see how identical and so different we are. This rich diversity and similarities make us unique.

When we try to understand human evolution, the perfection in timing, order to create a human being and move to try to figure out, decipher, interpret craniofacial growth, many questions arise.

Within the very narrow scope of humanity, that is just a speck of where we stand in an immeasurable and ever-expanding universe.

If this would be absolutely true, then this book would not have surfaced, because craniofacial growth does not follow solely Mendel's rules. Environment plays a crucial role in all of our lives; however, it significantly affects a growing child.

The younger the harmful environmental influences are removed (pacifier use or thumb sucking) or controlled (allergic child with diet or medicines), the better reversible results will be accomplished by our own genetic nature and without our interference, preventing possible potential permanent repercussions.

Adaptive changes during growth cannot be attributed to either genetic or environmental factors alone. However, it is clear that epigenetics plays a major role in determining how bony elements combine to create a harmonious or an undesirable growth pattern.

There are polygenetic inherited traits such as eyes or skin color.

Most metric traits are controlled by a few genetic loci, such as height and weight. However, pathological (heart, respiratory conditions) or environmental conditions can alter the final genetic influence (Falconer and Mackay 1996).

In this sense, the phenotypic expression of polygenic (multifactorial) characters is undergoing considerable modification by environmental influences after birth, which are seen in 70% of children with malocclusions (Diagram 1.4).

Malocclusions are not static; they can become exponential over time, with growth and development being the determining factors in the extension of malocclusions, and the obstacles along the way would be primarily environmental.

To reach a normocclusion, clinicians need to balance good genetics and a controlled environment from the first years of life. This will allow, in most cases, nature to reach class I, with or without our intervention, no matter if the patient is crowded and presents class II or class III malocclusions.

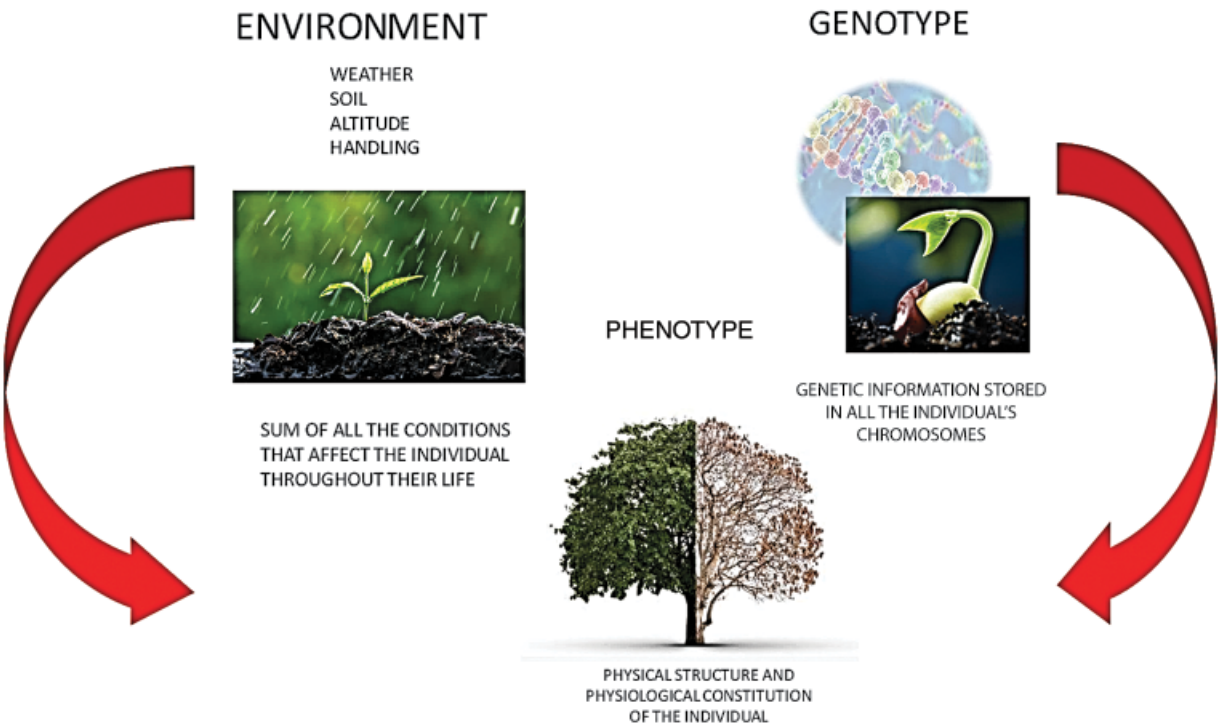


Diagram 1.4 In this diagram, we can exemplify the genetics, the environment, and the result of both (Phenotype). The sum of all the conditions that affect the individual during their life (Environment) and the genetic information stored in all chromosomes (Genetics) results in the individual's physical structure and physiological constitution.

Environment Examples

In general, we find in our clinics two types of environmental factors that cause most of our problems: Habits and airway problems.

They are the main determinants that generate class I and most of class II and class III cases.

During the 1980s, most of the children in Mexico presented a thumb-sucking habit. Pacifiers replaced this in the 2000s, and today we are returning slowly to thumb-sucking children.

Both create similar problems, but pacifiers are easier to remove earlier, so the impact on occlusion is generally diminished; however, some of its environmental impacts will prevail during the entire growth period (Figure 1.19).

Depending on the intensity of the sucking, frequency, and duration, the maxilla's environmental response will be greater and will also influence the mandible and tooth position. It might also develop a posterior crossbite. These alterations will reshape and readjust the direction of the expected growth process that is genetically programmed (Figure 1.20) (Diagram 1.5).

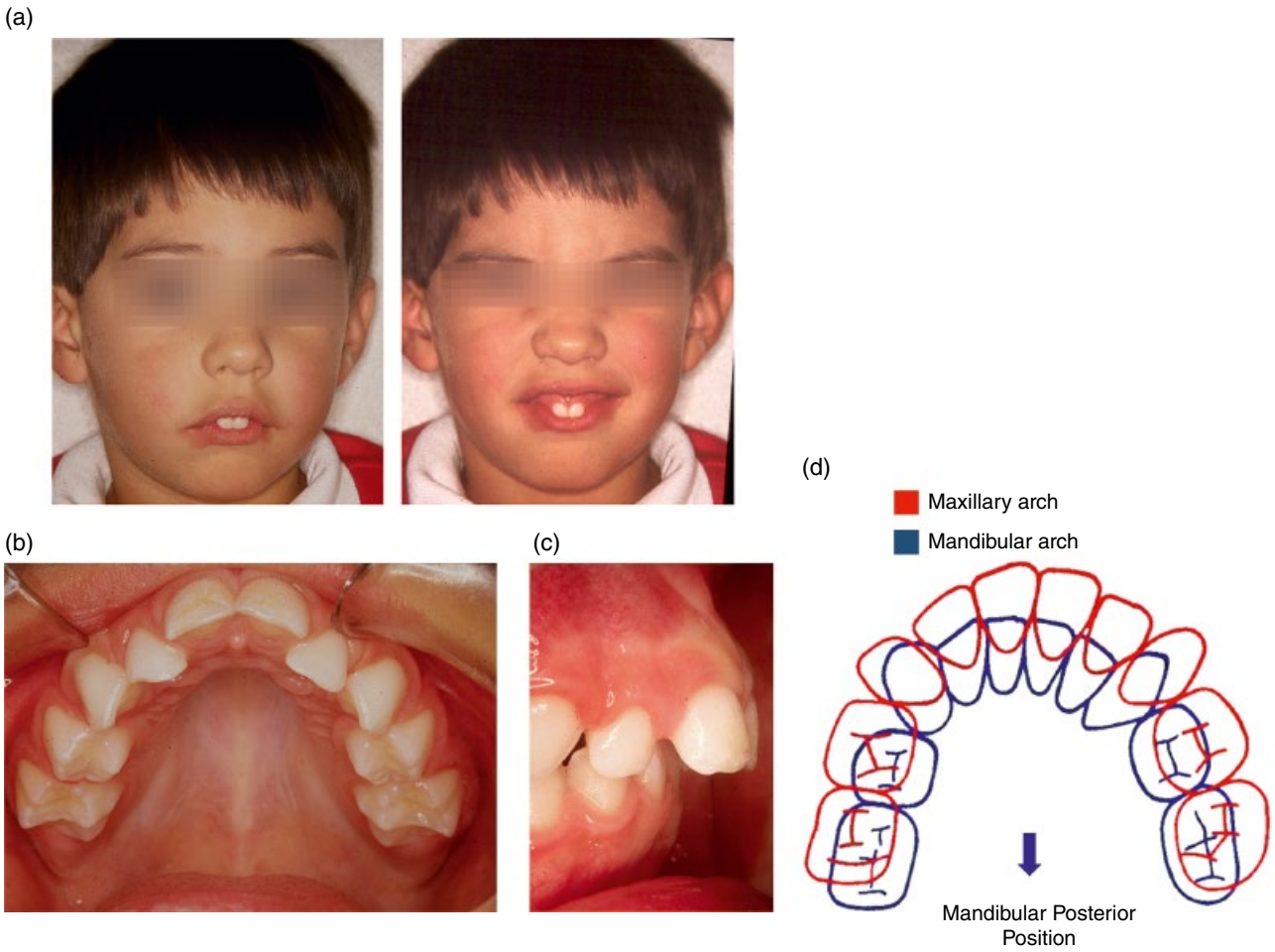


Figure 1.19 (a) Extraoral photographs of a four-year-old patient with no apparent environmental cause, (b) narrow triangular maxillary arch, (c and d) where occluding with the mandibular arch does not allow the mandible to displace physiologically forward. The mandibular arch assumes a forced distal position posterior to the maxilla, creating a class II canine relationship and a distal step molar relationship. If this relationship is maintained, from this moment, the patient will develop a real skeletal class II.

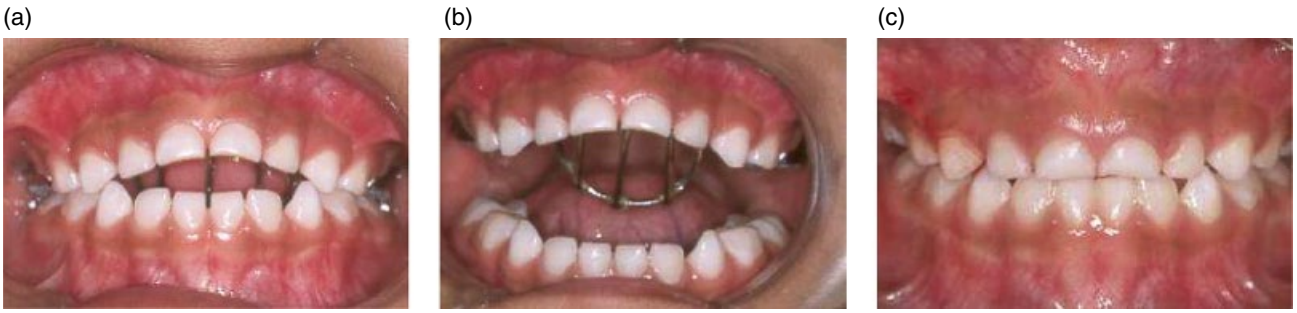


Figure 1.20 (a) Intraoral photographs of a four-year-old thumb-sucking child with an anterior open bite. (b) A fixed thumb crib was placed, which also helped to redirect the position of the tongue, not allowing it to project forward when eating, swallowing, or speaking. (c) Closing the bite after quitting the digital habit.

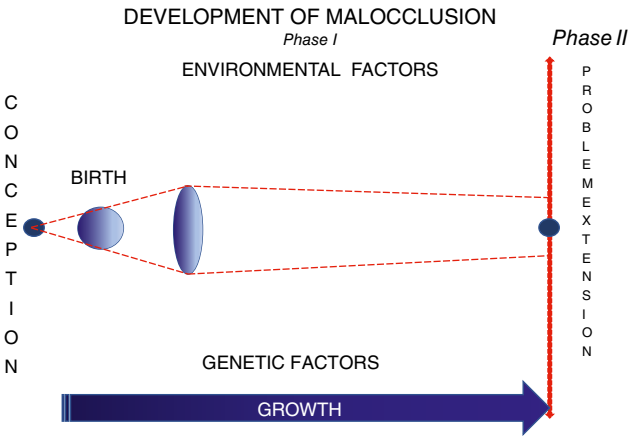
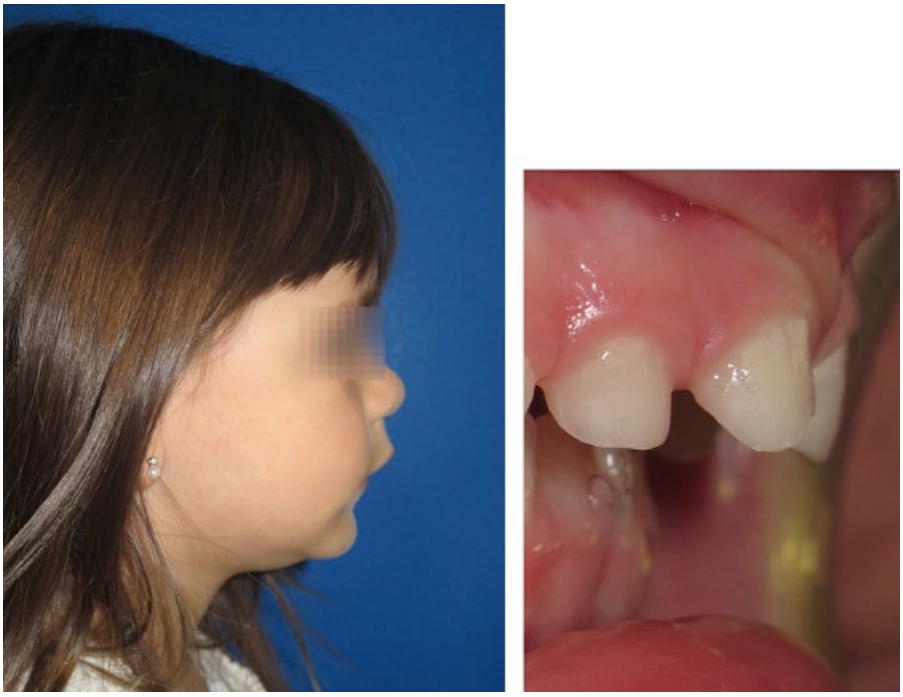


Diagram 1.5 Expression of malocclusion after birth caused by an alteration (genetic or environmental), where the habit is eliminated, and growth reoriented to have a decreased extension of the problem or self-correction depending on the age of the patient.

(a)



(b)

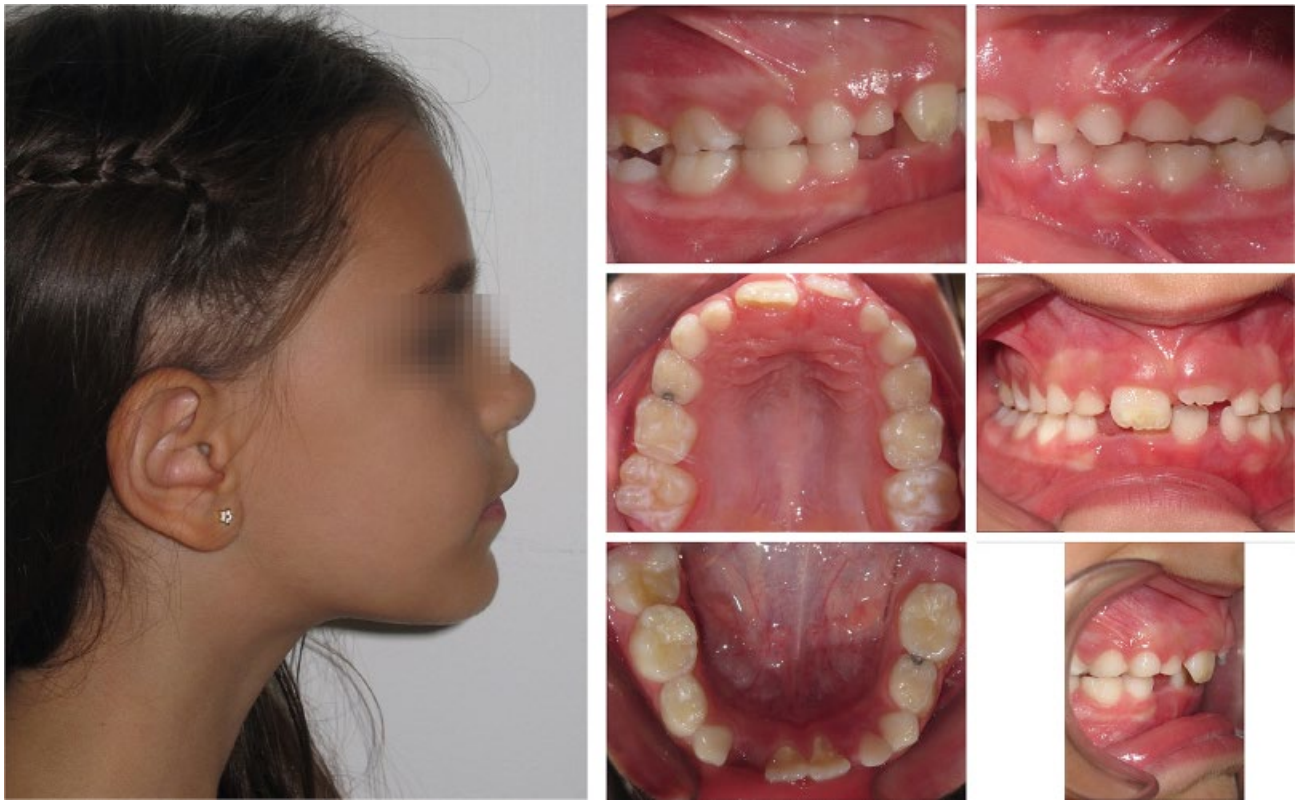
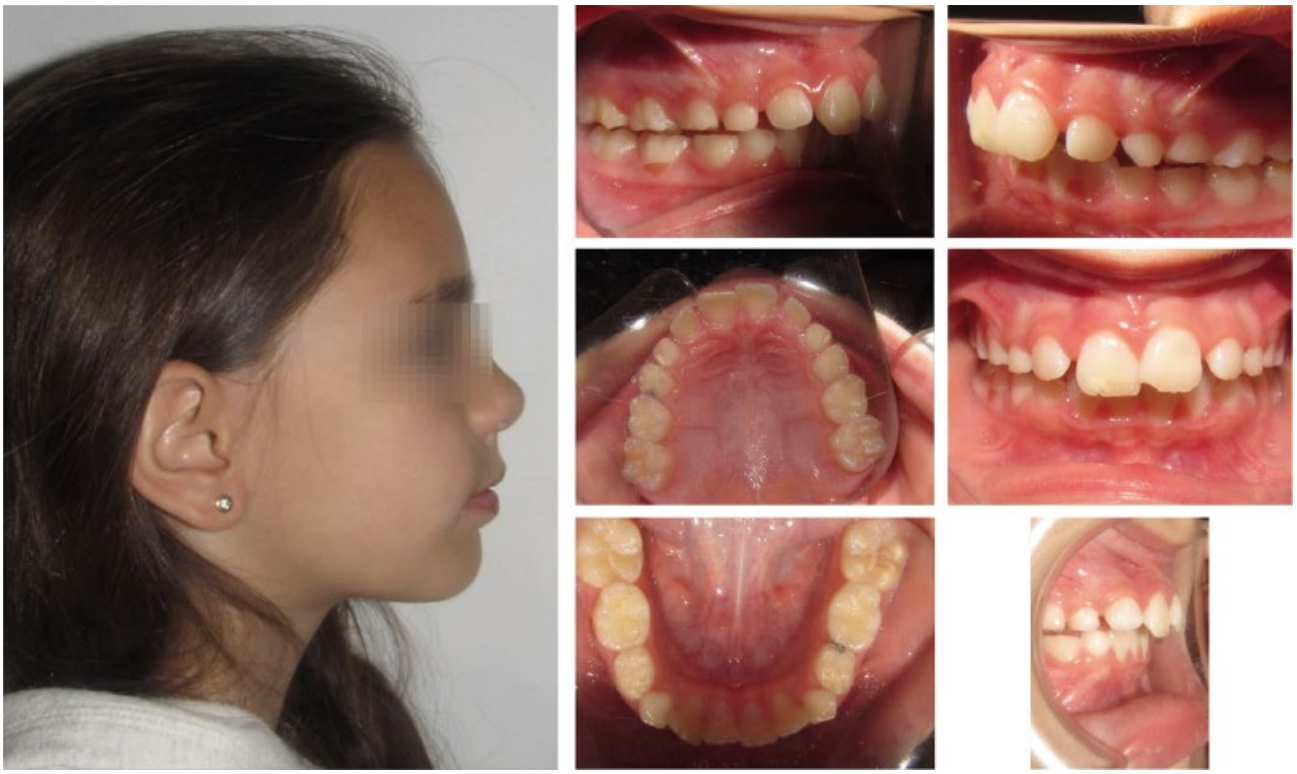


Figure 1.21 (Continued)

(c)



(d)

Figure 1.21 (a) Three-year and five-month old thumb-sucking class II patient did not stop the habit until a year later. She presented a large overjet, maxillary constriction, dentoalveolar protrusion, and a severe mandibular skeletal retrusion. (b) At age 7, after the environment resumed its expected growth, the patient presented an important class II molar and cuspid relationship, improved facial characteristics, and profile with a slight crowding and retroclined anterior central incisors. (c) Because of the slight crowding and retroclination of the maxillary central incisors, we decided to place a sagittal appliance (see Chapter 10, Management of Class II Malocclusions in the Primary, Mixed, and Early Permanent Dentitions) to procline and expand the maxillary arch. The mandible moved passively down ward and forward toward a class I molar relationship. (d) Changes in the patient's facial profile at the age of three years and six months, seven years, and eight years and six months. We can observe the changes in the mandible's forward passive displacement that created an esthetic profile.

Discussion

This case is simple. The environmental interference was removed early, and the growth resumed. When we see the patient again at at the age of seven, we might decide at this point to observe the class II molar relationship and let the mandible grow. Waiting will only aggravate her class II.

If this class II was genetic, we could have used a Bionator (see Chapter 10, Management of Class II Malocclusions in the Primary, Mixed, and Early Permanent Dentitions) to bring the mandible forward. However, we would have been skeptical because the acceptable patient profile could become a class III. The retroclined anterior central incisors at age 7, would inhibit the mandible's forward displacement, thus aggravating the class II situation. By just proclining the central incisors, we could see the mandible was free to move forward toward a class I and the facial profile could also be improved.

Nevertheless, if we used, for example, a 2×4 bracket with a wire and a compensating curve to procline these anterior teeth, the mandible would not have moved or only moved slightly forward (see complete case in Chapter 10).

Genetic Example (Growth and Development Failure in Early Stages)

When the patient presents an environmental or genetic imbalance in early stages with no treatment, there will be an exponentiation of the malocclusion than if it occurs in late stages. No early treatment can lead us to a complicated (surgical) situation.

In this case, we can see the first image when the girl was four years and eight months old with hemifacial hypertrophy characterized by a morphological anomaly of the maxillofacial region, resulting in excessive unilateral growth of all facial structures (bone, soft tissues, and teeth). It starts very early, where the neural crest cells divide more in one side than the other, creating a disparity that no early treatment nor surgery can entirely correct (Figure 1.22).

This case can be erroneously called hemifacial microsomia or hemifacial hypoplasia; however, it shows a more significant unilateral growth.

A wrong diagnosis led people from two different hospitals to perform exploratory surgeries "for a neoplasia." It is sad to confuse a problem due to a wrong diagnosis, performing unnecessary surgeries at age six and eight, furthermore deteriorating the patient's esthetics. Unfortunately, her growth response will also be disrupted by the surgical manipulation because the muscles contain the genetic components of bone growth.

The right side of her occlusion corresponds to her chronological age, while the affected left side shows an alteration in the development of the eruption with a premature eruption of permanent teeth, compared to the normal side. Bone growth and tooth sizes are also affected by the hypertrophic side difference in the mesiodistal and buccal lingual dental sizes (Figure 1.22).

Radiographically, the dental development of erupted and non-erupted teeth is also more significant in the affected areas (Figure 1.23).

The development of dentition has not been matched during growth. It follows the same developmental dynamic on each side with a difference of approximately three years between them (Figure 1.24).

Another example of exponentiation of malocclusions can be seen in this environmental origin case on a

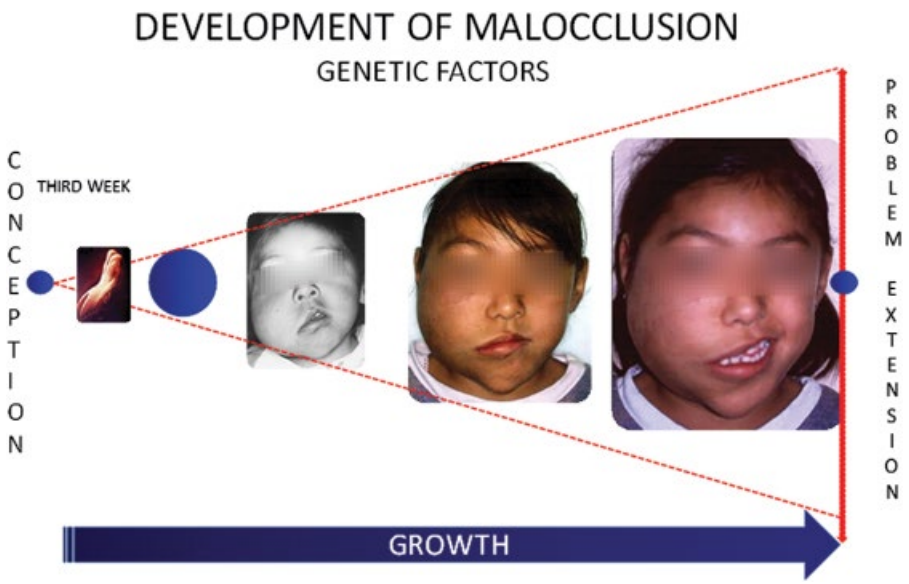


Diagram 1.6 Exponentiation of a pathological growth and development problem in this girl at the age of four years and eight months started in the third or fourth week of intrauterine life. See the progress at age six and eight. Surgeries were performed considering this growth as a neoplasm.

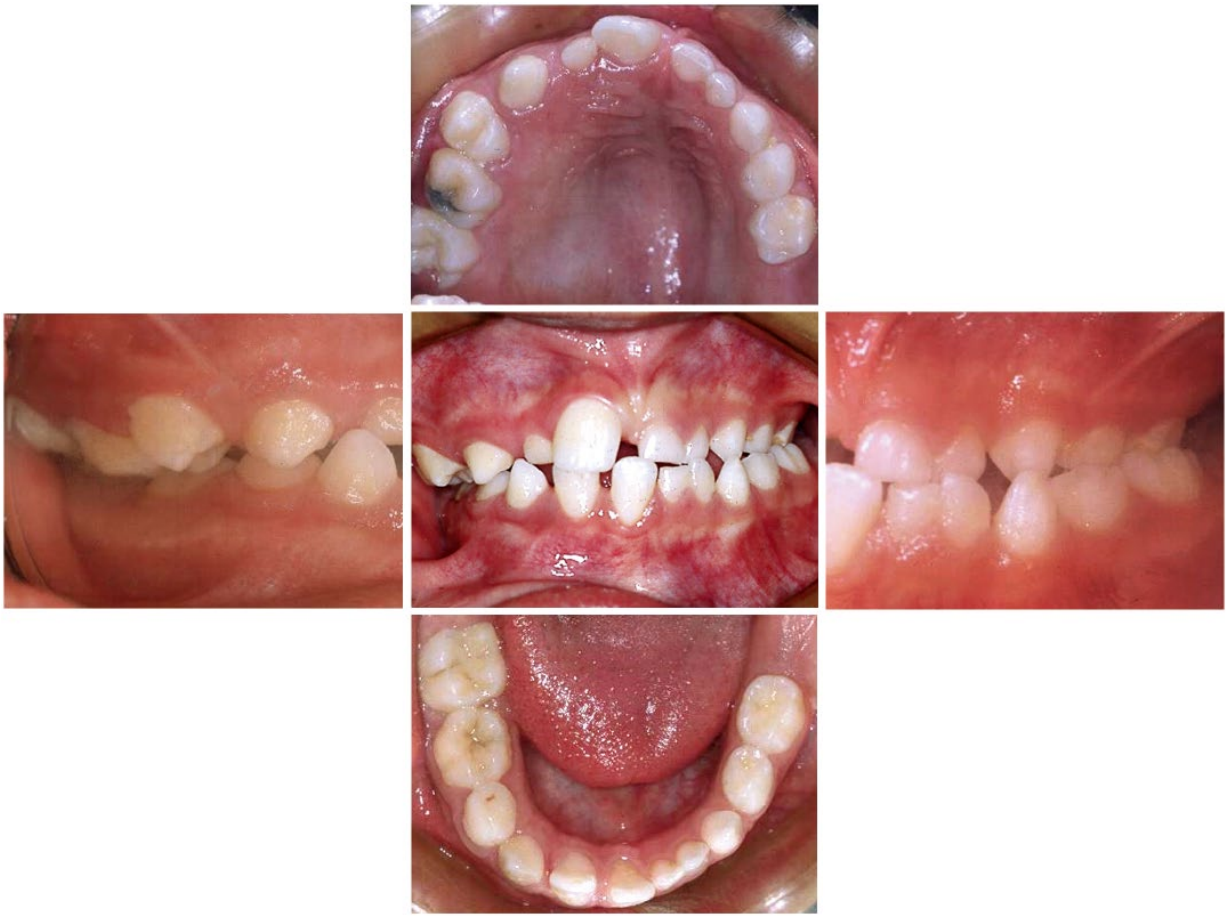
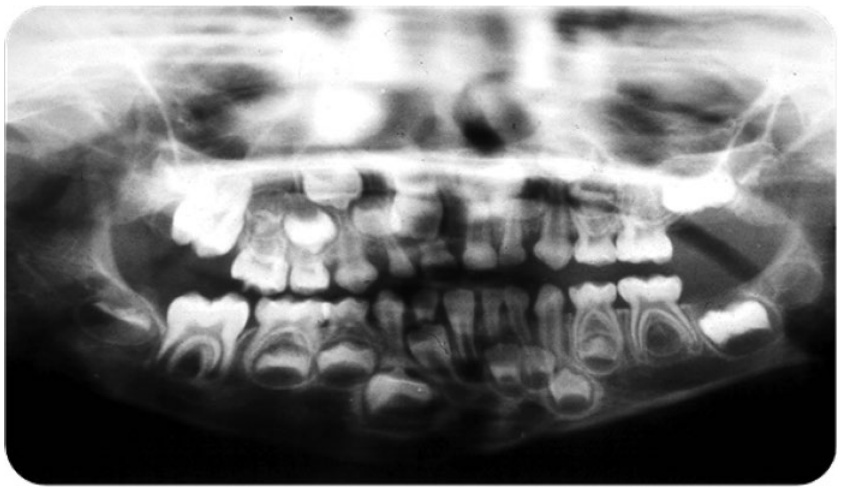


Figure 1.22 Clinical intraoral photographs show the development of dentition. The affected side shows significant premature permanent tooth eruptions. The non-affected follows an apparent normal tooth development and eruption.

Figure 1.23 Panoramic radiograph of the girl at four years and eight months. The dental development of erupted and non-erupted teeth is significantly greater in the affected areas.



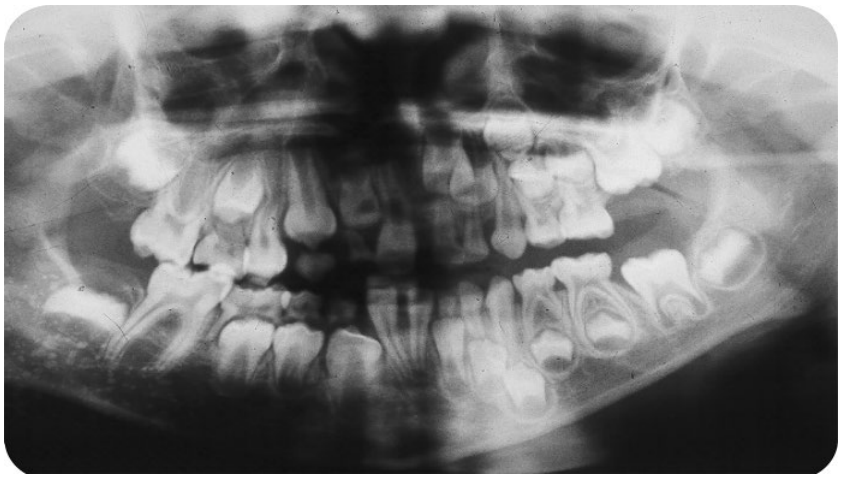


Figure 1.24 Panoramic radiograph of the girl at eight years. The differences in eruption timing between the affected side and the non-affected side can stretch by four years.

14-year-old adolescent, derived from a chronic thumb-sucking habit and duration of up to the age of three years and six months, causing a transverse maxillary constriction and a posterior crossbite. The problem aggravated because no early interception was implemented. Late treatment produced only alveolar changes with limited changes on the skeletal and esthetic characteristics (Figure 1.25).

If the crossbite was corrected early, it would not have ended up a surgical case from his severe asymmetry. Orthodontic treatment was performed, which could correct only most of the malocclusion.

Environmental Example

The condylar elongation and growth opposite to the crossbite side could be seen when the patient brought the radiograph to us for a second opinion (Figure 1.26).

A facial asymmetry grown exponentially over time can be observed as a transverse deficiency with a crossbite of the left upper first permanent molar with a midline deviation. We also see a dentoalveolar compensation with an inclination of the occlusal plane. (These photographs are from the patient brought to us for a second opinion (Figure 1.27)).

Even with a second-phase treatment, the change was only dentoalveolar enhancing the occlusion, but it was impossible to improve the facial asymmetry, so the patient would require preferably orthognathic surgery to compensate the asymmetric growth. It is essential to mention that from the previous photographs, surgery was predictable (Figure 1.28).

Another option for this case would be to surgically modify the chin's position and retain it with a myofunctional device (Figure 1.29).

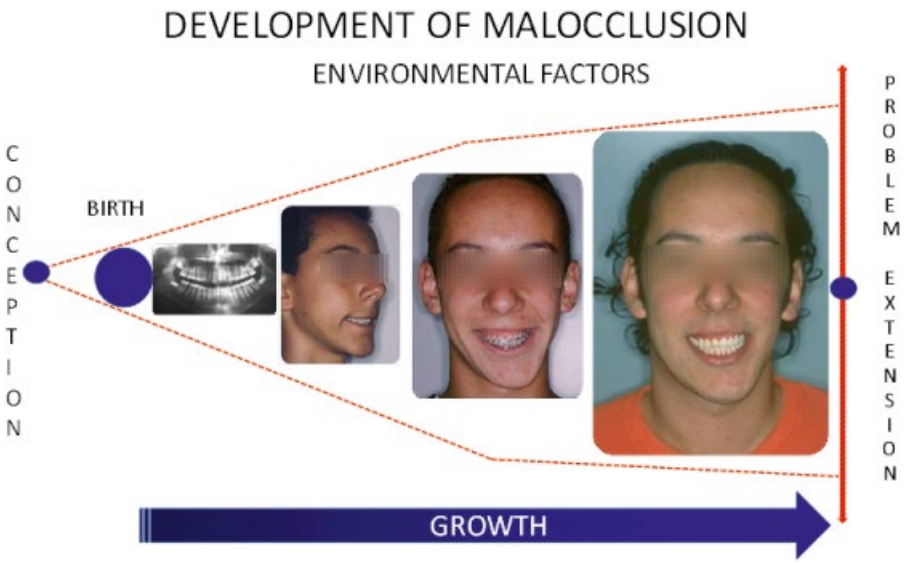


Figure 1.25 Severe lateral shift, which should need surgical manipulation. This problem could have been intercepted early with no sequela.