Skeletal Types: key to unraveling the mystery of facial beauty and its biologic significance

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(Editor's Note: From time to time, we will provide a French or Spanish summary of an article to serve our international members. The following French summary was prepared by Michel Champagne.)

TYPES SQUELETTEIQUES. Système de classification décrivant la position et la malposition des maxillaires.

L’auteur essaie de fixer les paramètres qui constituent l’idéal de la position facio-squelettique pour le maxillaire et la mandibule, et ceci peu importe le type racial. Il recherche des critères qui le guideront dans la découverte d’une position du maxillaire et de la mandibule relative à la base crânienne. Cette position doit maximiser l’esthétique faciale, la santé de l’ATM et l’harmonie physiologique de notre système.

Il oriente sa recherche vers le phénomène de la proportion divine, reliant le chiffre 1.618 à l’harmonie naturelle présente partout. Il applique donc cette mesure à la croissance cranio-faciale, stipulant qu’un visage proportionné selon un tel principe est harmonieux.

Il évalue également l’analyse céphalométrique de Sassouni dans sa version modifiée et démontre son application dans le diagnostique des anomalies cranio-faciales. Cette analyse lui semble une des plus appropriées dans notre contexte fonctionnel.

Skeletal types — classification system to denote ideal maxillary and mandibular position and malposition

Great advances are being made in the area of functional appliance therapy and orthognathic surgery. Our ability to make real and perceivable changes in the human face have revolutionized the breadth and care that our profession can provide for our patients. In the vast majority of cases, treatments for facial esthetics, temporomandibular disorder, and cranio-mandibular pain demand that the patients’ maxilla and mandible be treated to their proper and ideal position. To date, there are no definite guidelines as to what constitutes ideal facial-skeletal position for the maxilla and the mandible. Without establishing universal criteria that apply to all individuals regardless of race, sex, age, and other variables, accurate diagnosis and treatment can never be certain or comfortably achieved. The criteria for establishing ideal position of the maxilla and the mandible must be based on maximizing healthy temporomandibular joints, facial esthetics, and physiologic harmony. Just as Dr. Edward Angle firmly established criteria for ideal dental occlusion and developed a universally-accepted dental classification system, it is necessary for our profession now to establish firm criteria for ideal skeletal position of the maxilla and the mandible and to develop a universally-accepted facial-skeletal classification system.

Clarification of terminologies

Currently, there appears to be tremendous confusion in delineating dental problems from skeletal problems. Since dental and skeletal problems must be evaluated separately and distinctly from each other, the following terms are proposed to prevent confusion and unintentional merging of the two. Orthodontic applies to the correction of dental problems whereas orthopedic applies to the correction of skeletal problems. Occlusion and malocclusion describe the way the maxillary and the mandibular teeth relate to each other. Position and malposition describe the way the maxillary and mandibular skeletal components relate to the cranial base.

Whereas malposition describes the abnormal position of the maxilla and/or the mandible, malformation describes the abnormal shapes of the maxilla and the
mandible, i.e. the maxilla is malformed when it is constricted and has a high and narrow palatal vault. Retrusive and protrusive describe the posterior and anterior position of dentitions, whereas retrognathic and prognathic describe the posterior and anterior position of the maxilla and/or the mandible relative to the cranial base. Open-bite and deep-bite describe the vertical height relationship of the dentition; long and short describe the vertical height of the lower half of the facial-skeletal structures relative to the upper half of the face. These terms are used because they are directly related to "long" face and "short" face syndrome. Finally and more importantly, Class refers to dental classifications which include dental Class I, Class II, and Class III whereas Type refers to skeletal classifications such as skeletal Type I, Type II and Type III. These distinctions must be made so that in discussing dental and skeletal abnormalities, one will not be confused with the other.

Introduction

When using the term "deep bites," are we speaking of dental deep bites, skeletal deep bites, or a combination of both? It is not only important but absolutely essential to make these distinctions in treating orthodontic patients with this and other skeletal problems. In fact, the treatment of skeletal abnormalities has greater aesthetic and physiologic impact on the patient than the treatment of dental abnormalities.

Even to this day, there appears to be ambiguity and confusion in delineating dental and skeletal problems. Many practitioners assume that the maxillary/mandibular A-P position always coincides with the dental A-P position; that Type II skeletal always follows Class II dental and that Type III skeletal always follows Class III dental. This unintentional merging of these two distinct problems, as if they were conjoined Siamese twins, may have occurred in the early years of our profession because diagnostic assessments were not as sophisticated. Since the ability to make changes in the craniofacial structure was limited at that time, skeletal diagnosis and treatment were rarely considered or emphasized. On the contrary, there are many instances where the skeletal A-P position does not necessarily follow dental A-P position. In their article, Milacic & Markovic found that not all skeletal malpositions coincided with dental malocclusions. There are patients, for instance, who have Type III skeletal with a Class I dental, and Type I skeletal with a Class II dental. These are just a few of many such examples.

Once we firmly establish that dental and skeletal problems are separate and distinct from each other, then we must firmly establish normal or ideal from the abnormal. Without this knowledge, there is no definitive line separating normal from abnormal conditions. This can create a diagnostic nightmare. For instance, how can practitioners correct dental malocclusions if there is no agreement as to what is considered ideal occlusion? In 1899, Angle clearly described and illustrated this. Previous to his landmark publication, many practitioners did not really know for sure. They were essentially treating blindly with oftentimes unacceptable results. Furthermore, various types of abnormal occlusions were described in vague terms, which added to the confusion. By defining ideal dental conditions and classifying the various malocclusions in a neat and efficient manner, Angle helped to crystallize once and for all how to diagnose the various types of malocclusions and how to achieve normalcy in dental occlusion.

Almost 100 years later, we are faced with a similar situation with respect to skeletal problems. There is still no definitive agreement as to what constitutes normal or ideal facial-skeletal position. Without this information, many practitioners continue to disregard them. Worse yet, practitioners, with little appreciation for skeletal abnormalities, may inadvertently reposition the maxilla and/or the mandible further away from the ideal while treating orthodontic patients. This can result in severe consequences to the patients. Rather than improve the human condition, this may adversely affect the patients' facial appearance and health.

The orthodontic profession is now very cognizant of the benefits of functional appliance therapy. This therapy, along with orthognathic surgery, has enabled us to change the size, shape, and position of the maxilla and the mandible. It has allowed our profession to help our patients far beyond the narrow confines of the oral cavity. This ability to correct facial-skeletal abnormalities can only help to break away our self-imposed image as mere "tooth" doctors and elevate our profession to that of "real" doctors. However, in order for us to help our patients correctly and effectively, we must firmly establish a universal standard for ideal facial-skeletal position.

Currently, there is literature discussion and cephalometric analyses that deal with the assessment of normal facial-skeletal position. To date, none appear to be universally accepted because they are vague, complicated, and sometimes contradictory. Furthermore, there are different values for different segments of the population depending on race, age, sex, etc. Too often, many authors feel that facial bone structures and facial features are genetically influenced and diverse. They believe, for example, that Caucasian standards do not apply to Blacks, and vice versa. If this were to be true, then it would be a formidable task to establish ideal facial-skeletal position for every single segment of the human population. Furthermore, the constant intermingling between the different races and cultures makes this task even more difficult, if not impossible.

A popular view held today is that most human
variations are genetically controlled and attempts to interfere with these variations are not recommended. It is my view that most physical variations, especially the extreme ones, are environmentally induced and should be corrected as closely as possible to the biological standard that is esthetically pleasing and physiologically healthy. As will be explained further, all creatures including man, are genetically encoded to develop into an ideal and defined proportion. This proportion is universal and directly impacts on esthetics and biological health. Because of environmental factors, most living creatures deviate somewhat from the ideal. In a perfect world, free of extreme climatic conditions, stress, abnormal myofunctional habits, pollution, toxins, allergens, etc., most living creatures should develop to this ideal proportion. A universal standard for ideal facial esthetics and ideal facial-skeletal position will be established based on the premises mentioned.

A universal standard for ideal facial esthetics/facial-skeletal position can be established if practitioners and scholars emphasize common characteristics rather than differences. Realistically, when the anatomy of the human head and face is analyzed, superficial surface distinctions such as facial features, skin color, and hair essentially have nothing to do with the basic biology of human differences. Compared to the overall genetic make-up and the physical architecture of the human body and face, any differences are so insignificant that they may be considered non-existent.

Based on clinical and cephalometric observations of esthetic, biologic, and physiologic characteristics common to the human race, I have been able to establish a universal standard for normal or ideal skeletal position of the maxilla and the mandible. The Skeletal Archial Analysis (formerly called the Modified Sassouni Analysis) effectively assesses facial-skeletal problems. The establishment of a skeletal classification system somewhat analogous to Angle's dental classification was necessary to describe the many forms of skeletal malposition that became apparent when using the Skeletal Archial Analysis.

By treating patients towards ideal skeletal position, many benefits can be observed. These benefits include improved facial esthetics, enhanced TMJ health, and improved physiologic harmony. Physiologic harmony (the least understood of the 3 benefits) includes alleviation of severe and chronic headaches, mouth breathing, otitis media, myofacial pain, etc. In essence, the criteria used to establish ideal skeletal position of the maxilla and the mandible relative to the cranial base were that it enhanced facial esthetics, improved TMJ joint health, and improved physiologic harmony.

Universal nature of the human race and human face

All living creatures — including man — are intimately connected by a biologic phenomenon known as divine proportion. We are all genetically encoded to develop into this ideal shape and form for many reasons. Ricketts' notes that biologists and morphologists understand this, and they speak in terms of "laws." When the human body develops to this divine proportion, it upholds the first law of "conservation of energy," which means that there is maximum performance with minimum effort. It also upholds the second law of "conservation of tissue," which means that a minimum amount of cells and materials are employed to perform the needed task. To put it bluntly, any individuals who conform to this divine proportion are biologically and physiologically arranged to be profoundly efficient and healthy.

Thornhill and Gangestad stated that ideal physical development such as facial and body bilateral symmetry is necessary for many animals, including humans, to be attractive, healthy, strong, and resistant to parasites. Leary and Allendorf stated that environmental stress is often associated with abnormal development. They cite, for example, grunion (Leuresthes tenuis), a marine fish which exhibited increasing pectoral fin ray asymmetry with exposure to increased concentration of DDT during development. A high incidence of asymmetrical development of fish was found in waters around industrial centers. Rats subjected to a variety of environmental stresses during pregnancy produced greater incidence of abnormally-developed offspring than the control group. Recently, the nuclear explosion in Chernobyl has produced significantly higher incidence of physical defects in new-born animals and humans. In our own practice,

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**Inner Peace...**

Can there be anything more wondrous than the splendor of nature? Where the earth, sun, and water come together in perfect harmony to allow the miracle of life to flourish along the harsh realities of our foreboding planet.

Is there anything more inspiring than to dwell among the deep blue endless sky, majestic mountains, and the emerald seas? A brilliant tapestry of colors, sights, and sounds intertwined in perfect balance, peace, and tranquility.

And nothing seems, can cause time to stand still than to chance upon a face of perfect proportion and harmony. Its every curve, texture, and configuration lay bare its strength, character, and all its human emotions.

Through it all, our existence pales against all that surrounds us, reminding us that there is a Being far greater than ourselves. And yet, we have the gift to celebrate life to its fullest or we can descend into hell here on earth if we so choose.

We yearn to reach out and peer far beyond the universe only to find that the Truth lies deep within our soul. Ultimately, the restlessness from within can only be forever calmed by the union of our mind, body, and spirit...in perfect harmony.

—Yosh Jefferson, March 1996

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we see evidence of long face syndrome which may be attributed to natural and man-made allergens. It is environmental factors, not genetics, that cause abnormal facial and body developments.

**Divine proportion**

As described by Ricketts in his article, esthetic appreciation of shapes and forms was first described by Phidias, a Greek sculptor. He noticed an ordered relationship of spatially-related parts in nature, later defined as divine or golden proportion, that are instinctively appreciated as being beautiful. Ricketts credits Filius Bonacci as the discoverer of the numerical value of the divine proportion. This scholar, in 1202, published his findings that the multiplication rate of rabbits did not increase in an ordinary geometric progression. Eventually, the population level reached a point where each new addition grew at precisely 1.618 times the previous number, and this ratio of added population continued on into infinity. This number, 1.618, applies to all living organisms and biologic entities; for example, an egg once fertilized will multiply and divide until it reaches a point where each succeeding number of cells will be exactly 1.618 the number of previous cells. For whatever reason, there appears to be a mysterious and biologic significance to the number **1.618**.

The knowledge of divine proportion was well known to Leonardo Da Vinci. There is no greater example of this anywhere than his famous drawing, Human Figure in a Circle, Illustrating Proportions, 1485-90. As illustrated in Fig. 1, if the distance from the top of the head to the umbilicus is 1, then the distance from the umbilicus to the toe is 1.618. Also, if the distance from the right shoulder to the tip of the left finger is 1, then the total height of the human body (head to toe) is 1.618. These are just a few of the many examples that can be found.

The human face must also conform to the divine proportion in order for it to be biologically efficient and viable. Fig. 2 shows some of the vertical relationships of the face that must conform to this ideal. For example,

![Fig. 2: Divine proportion of the face, vertical relationship.](image)

if the distance from LN (lateral side of the nose) to ME (soft tissue menton) is 1, then the distance from LN to TRI (Trichion-beginning of forehead wrinkling when one lifts the eyebrow) is 1.618. Also, if the distance from CH (Cheilion-corner of the mouth) to ME is 1, then the distance from LC (lateral canthus of the eyes) to CH is 1.618.

Fig. 3 shows a few transverse relationships of the face that must conform to the divine proportion. For example, if the distance between LN is 1, then the distance between CH is 1.618. The distance between LC is 1.618 squared, and the distance between the temporal soft tissue of the level of the eyebrow is 1.618 cubed or 4.236.

Fig. 4 shows that the external dimension of the head must also conform to the divine proportion. Ideally, if the distance from LCHK (lateral border of the cheeks) is 1, then the distance from TH (top of the head) to Me (soft tissue menton) should be 1.618. The divine proportion is universal and applies to all individuals, regardless of race, age, sex, geographic and cultural variabilities.

Facial form and balance is directly related to divine proportion. Fig. 5 shows a beautiful face of a female model. Because the model is bald, external measurements of her face were easily obtained. The length of her face (top of her head to the bottom of her chin or menton) was 1.618 of that of her width (from lateral borders of her cheek to lateral borders of her...
cheek). The external configuration of her face conformed to the divine proportion. If the length of the face is longer than 1.618, then the patient will have long face syndrome. If the length of the face is shorter than 1.618, then the face will have a short face syndrome.

Practical application of the divine proportion in treating patients toward enhanced facial esthetics was demonstrated by Mack. In essence, treating patients toward this ideal spatial relationship can improve facial appearance. For example, in patients with short face syndrome where the lower facial height is skeletally short, he was able to improve their facial appearance dramatically by increasing the lower facial height closer in line with the divine proportion.

The concept of divine proportion lends support to my contention that a universal standard for ideal skeletal
position is not only possible, but necessary. Necessary because all creatures including humans are genetically predisposed to develop toward ideal proportion. As noted earlier, development toward ideal proportion maximizes efficiency and health. As will be explained later, faces that do not conform to the divine proportion not only have esthetic problems, but physiologic problems as well. Because of external and environmental factors, many individuals do not develop toward this ideal proportion.

**Facial esthetics**

The position of the underlying bone has a direct impact on facial appearance. If positioned ideally, it should enhance facial esthetics. Numerous articles in the literature have attempted to define facial beauty or esthetics. Too often, many scholars feel that facial beauty is subjective and culturally influenced. This type of thinking creates an impossible task of establishing a universal standard for ideal skeletal position, as well as a universal standard for ideal facial esthetics. By ignoring superficial differences and by comparing unique characteristics that are common to the human face, a universal standard for ideal esthetics/facial-skeletal position can be established.

Facial beauty is directly related to divine proportion. Because divine proportion is universal, then it stands to reason that facial beauty can also be universal. The appreciation for beauty is also genetically controlled. The capacity to select and to seek out beauty is instinctive, and as Ricketts states, "This level of perception is not in the cognitive part of the brain, but is thought to be located within the subconscious or primitive portion of the brain referred to as the reptilian complex or the limbic system." This has enormous social implication. For example, in seeking out potential mates, all living creatures, including humans, seek out those that arouse the senses to an emotional level of pleasure. In other words, there is an instinctive drive to seek out mates that are ideally proportioned. In so doing, we subconsciously seek out mates that are maximally healthy and vigorous to insure survival for ourselves and our offspring. Many researchers propose that sexual selection favors those facial and body traits that physically advertise their strength, high reproductive capacity, and resistance to micro and macro parasites.

Many studies have shown the universality of facial beauty. For instance, there is a high degree of agreement among examiners when assessing facial attractiveness from photographs. A number of recent cross-cultural researchers have shown that the bases for judging facial attractiveness were consistent across cultural lines. They showed that racially and ethnically diverse faces possessed similar facial features that were deemed desirable and attractive, regardless of the racial and cultural background of the face being judged and regardless of the racial and cultural background of the perceiver.

Langlois et al., Samuels & Ewy, and Shapiro et al. were able to show that babies as young as three months can distinguish between attractive and unattractive faces. Because babies at this age are deemed too young to be substantially exposed to cultural standards of beauty, these studies indicate an innate ability of all human individuals to appreciate facial form and balance that have universal appeal. The attractiveness of the face had everything to do with facial balance and harmony, and very little to do with race, age, sex, etc.

Figs. 6, 7, and 8 show various types of facial profiles that can be found in the general population. If a poll were taken by the general population as to which facial profile would be considered the most attractive, the vast majority would select face F. This classic profile is universal and is not limited to any single race, age, or sex. Ideal facial-skeletal position frames the soft tissue to this profile.
To emphasize the universality of facial beauty, please analyze Fig. 9. The face to the left has universal appeal and would be universally accepted as being truly beautiful. What is amazing is that this face is not of a real individual but a computerized composite picture of four beautiful models which is shown to the right.

Fig. 9: Ideal image of a beautiful face produced by Nancy Burson; software design by David Kramlich. Right models photographed from top to bottom: Tiziano Magni, Walter Chin, Tiziano Magni, Walter Chin. Permitted use of photographs by Vogue Magazine.

The best features from these models from top to bottom, Karen Alexander, Lauren Lindberg, Cordula, and Kara Young, were digitized and combined to create this “perfect face.” If we were to disregard skin color as a factor entirely, it would appear that this computerized, “perfect” face shares many of the features seen on Karen Alexander, who is obviously a very beautiful, Black, model. By visually cross-referencing the computerized image of the beautiful face to the four models, we can see that all beautiful faces share common features.

Finally, there are no other illustrations that can dramatize the universality of facial beauty better than the pictures shown in Fig. 10. These pictures basically illustrate four beautiful faces representing each of the major racial types. The picture on the top left is that of a beautiful Black woman. The one on the top right is that of a beautiful Asian woman, and the one on the bottom left is that of a beautiful Caucasian woman. In actuality, they are all pictures of the same woman which is the one on the bottom right. The shape, size, configuration, and proportion of the four faces are exactly the same; the only difference is the makeup and the wigs.
This illustration clearly supports what was stated earlier. When the gross anatomy of the human head and face is analyzed, surface distinction of skin color, hair and facial features, etc. have nothing to do with the basic biology of human differences. Compared to the common genetic thread that binds all human beings to one another, any physical differences are so insignificant that they are almost non-existent.

**TMJ health and physiologic harmony**

The position of underlying bone has a direct effect on the health of TMJ joints and physiologic harmony. See Fig. 11. Patients who are dolicho facial (long face syndrome) tend to have upper airway obstructions and temporomandibular disorder.\(^{45,46,47}\) Patients who are extremely brachy facial (short face syndrome) tend to have severe myofascial pain and temporomandibular disorder.\(^{46,49,50}\) Patients who are meso facial (ideal facial proportion and profile), tend to have very little problems in the way of TMD and physiologic problems. These observations support the various biologic laws discussed earlier, such as conservation of energy and conservation of tissue.

Fonder\(^ {51,52}\), described many physiologic and TMD benefits to patients when the facial-skeletal structures are treated to their proper position. He showed actual cases of patients who had scoliosis. Once facial-skeletal correction was made either through orthodontic treatment or bite plane appliance, he observed significant straightening of the spinal column. He noted other physiologic benefits including alleviation of TMD symptoms, improvement of respiratory disorders and allergic symptoms, increased hearing acuity, and

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**Fig. 10:** These pictures illustrate beautiful faces representing the major racial types. Illustration from New Woman Magazine. Makeup by Paddy Crofton for the Makeup Shop, NYC. Permitted use of photograph by Todd Eberle, photographer.

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**Fig. 11**

_DOLICHO FACIAL_  _BRACHY FACIAL_  _MESOFACIAL_
improvement in skin disorders and rashes. He, along with Olsen et al., found that women who had cranio-mandibular dysfunction (TMD) had significantly more premenstrual complaints and other gynecological problems, such as premenstrual syndrome and infertility. Smith supported many of Fonder’s findings.

Even more fascinating, Fonder cited the case of a 12-year-old male patient who had mental retardation, grand mal seizures, and severe head forward posture. He had been diagnosed as microcephalic with the epicanthus not fully developed. His mandibular position and vertical was corrected initially with a TMD splint and later with bonded pivotal bilateral molar buildup. The treatment results were dramatic. His posture improved and his seizures decreased significantly in number and duration. There was also elimination of chronic fatigue syndrome, improvement of mental acuity and memory, better respiration, and a lessening of depression.

Marasa & Ham and Loudon cited improvement in otitis media in children by increasing skeletally short verticals via primary molar builds. Jefferson cited improvement of TMD symptoms and other physiologic problems when skeletally short and/or retrognathic mandibles were moved to the physiologically correct position either through orthodontic/orthopedic therapy or through orthotic appliance therapy. Conversely, moving the mandible to the incorrect position can augment TMD symptoms and cause other physiologic problems. Kahnberg studied 13 patients who underwent maxillary osteotomy with superior repositioning of the maxilla for correction of open-bite deformity and maxillary excess. Sixty percent of these patients developed TMD symptoms.

The cranio-mandibular structure has a tremendous impact on the total health of the human body. As explained in Fonder’s text where many of the references were cited, it is because the jaws and the dental structures (except tooth enamel) are formed from the neural crest cells along with the endocrine system, while the central nervous system is formed from the neural tube. The entire nervous system, the endocrine system, and the dental system are formed from these embryonic cells. Since the jaw and the nerves have common tissue origin, there appears to be a strong structural and physiological connection. The oral cavity and the cranio-mandibular complex are highly innervated and have strong proprioceptive mechanisms. Any hard tissue malignment and impingement has the potential to send messages to the brain which in turn will cause the body to respond — even in the unhealthy manner.

Along with the cranio-mandibular’s close association with the nervous system, it is my opinion that faces that do not conform to ideal biologic proportions create biomechanic problems within the architectural framework of the craniofacial structure. This can create what I call hard tissue impingement of vital biologic functions. That is why patients with long face syndrome tend to have nasal airway obstruction because the hard tissues of the sinuses cavities are narrow and compressed. That is why patients with short face syndrome tend to suffer from severe and chronic migraine headaches because the hard tissues of the head of the condyles tend to press up against the glenoid fossa. This may impinge on vital structures such as the auriculotemporal nerve and the superficial temporal artery which can create pain symptoms.

There are many other examples of hard tissue impingement due to facial-skeletal disharmony that can create physiologic problems. Patients with retrognathic mandibles tend to have head-forward posture. This head-forward position helps to alleviate the posteriorly displaced mandible from compressing the trachea which can obstruct airflow. The weight of the head in head-forward posture places tremendous strain on the spine and muscles of the neck and shoulders which can cause neck, shoulder and back pain. Furthermore, posterior cross bites and uneven mandibular planes of occlusion tend to cause lateral bending of the spinal column. This explains why Fonder noted improvement of scoliosis with bite plane therapy.

The importance of correct facial-skeletal position has been expounded by other researchers. Stoll stated, “Correct posture of the mandible is a prerequisite for good body mechanics and physical fitness. It is acknowledged that good posture statically and dynamically is essential for health and conservation of energy, and the first prerequisite for it is alignment of all the skeletal parts in harmony with gravity and balance.”

Cephalometric analysis of choice

An appropriate cephalometric analysis can help in the assessment of facial-skeletal disharmony. There are many analyses that can be used, some better than others. For instance, Downs used angle of convexity for the maxilla and facial angle for the mandible in determining their skeletal position. Steiner used the SNA angle for the maxilla and SNB for the mandible in their positional determination. Using linear measurements, Koski used Op-Pr for the maxilla and Op-Ip for the mandible and compared them to OP-ANS to determine their A-P position. McNamara in conjunction with soft tissue evaluation, measured the distance of A-point for the maxilla and pogonion for the mandible from nasion perpendicular to assess their A-P relationship to the cranium. These analyses are helpful, but most do not give all of the information necessary to help make an accurate skeletal diagnosis. Furthermore, most are based on sets of ideals determined by group samples and not based on ideal biologic proportion.
To diagnose proper facial-skeletal relationship accurately, the analysis must assess the anterior-posterior position of the maxilla and the mandible to each other. More importantly, it must assess maxillary and mandibular anterior-posterior relationship to the cranial base, as well as the vertical relationship of the mandible to the cranial base. McNamara’s cephalometric analysis is very good in satisfying these requirements. It references off the nasion perpendicular as its cranial base, and it does assess lower facial vertical height. The one negative is that it has different sets of norms depending on age and sex of the patients.

Ideally, a cephalometric analysis should be:
1. Easy to trace — should have minimal number of landmarks.
2. Easy to diagnose — should provide visual comparison of patients to the ideal norm, and not columns of angular and linear measurements.
3. Efficient — should not take more than ten minutes to trace and diagnose.
4. Universal — norm should apply to all individuals, regardless of race, sex, age, etc.
5. Accurate.
6. Based on biologic proportion — should assess skeletal disharmony based on the divine proportion.

The cephalometric analysis of choice, in my opinion, is the Skeletal Archial Analysis. The tracing technique and the interpretation of this analysis is fully detailed in the March, 1990, issue of the Journal of General Orthodontics which was then called the Modified Sassouni Analysis. This analysis evolved from the great works of Sassouni and Beistle. However, the Skeletal Archial Analysis is much more abbreviated and streamlined. Also, because the parallel plane is complicated to describe and to extrapolate, I have replaced it with a plane that I discovered which I call the ”cranial plane.” The Skeletal Archial Analysis is easy to trace and diagnose, efficient, universal, accurate, and based on the divine proportion. Much of the following landmarks and tracing techniques were borrowed from Beistle’s article.

Landmarks for this analysis are very similar to the Steiner analysis. However, there are few additional landmarks. See Fig. 12. They include:
1. Clivus
2. Roof of orbit
3. Basisphenoid
4. Greater wing of Sphenoid
5. Ethmoid cribriform plate
6. Lateral wall of orbit

Once all the anatomic landmarks are drawn, important Sassouni points should be plotted. Refer to Fig. 12. These points are defined as:

1. SO (supraorbitale): Most anterior point of the intersection of the shadow of roof of orbit and its lateral contour.
2. SI (sella inferior): Lower-most point on the internal contour of the sella turcica.
3. ANS (anterior nasal spine): Anterior tip of premaxilla on midsagittal plane.
4. PNS (posterior nasal spine): Most posterior point on the contour of the maxillary bony plate.
5. C.G. (constructed gonion): The intersection of two lines, of which one line is drawn from articulare and runs tangent to the posterior border of ramus, and the other line is drawn from menton and runs tangent to the lower border of corpus. This point is usually a few millimeters distal and inferior to actual gonion.

Once the Sassouni points are determined, the four major planes of the face should be established. Refer to Fig. 13. In the Skeletal Archial Analysis, Sassouni’s parallel plane will be replaced with the cranial plane which is easier to extrapolate and trace. The four planes crucial to this analysis are:
1. Cranial plane: Line drawn from SO to SI and extended posteriorly.
2. Palatal plane: Line drawn from ANS to PNS and extended posteriorly.
3. Occlusal plane: Line drawn from the functional occlusal plane through the bicuspids and molars.
4. Mandibular plane: Line drawn from menton running tangent to the lower border of corpus and passing through constructed gonion.

When the four major planes are established, draw and extend these four lines posteriorly. The appearance of these planes should be such that they converge toward an area where the four major planes are most concentrated, and then they begin to diverge. Crucial to the Skeletal Archial Analysis is the ability to locate Center “O.” Refer to Fig. 14. Center “O” is shown and labeled. In this tracing, the four planes almost converge to a point; in most cases, the four planes to Center “O” will not converge quite so tightly together.

Fig. 14: Center “O,” arcs of reference.

To determine Center “O,” draw parallel vertical lines between the most divergent planes going from anterior to posterior. These lines either remain equal in length for a short distance or start increasing in vertical height. Center “O” is located at the midpoint of the shortest vertical line. In most patients, the planes usually converge toward an area about the size of a dime. Once Center “O” is established, arcs are drawn with a compass. Although the Sassouni Archial Analysis uses many arcs of reference, the Skeletal Archial Analysis uses only three arcs of reference which are the most crucial in assessing facial-skeletal disharmony. They are the anterior arc, age 4 vertical arc, and the age 18 vertical arc. The anterior arc assesses the anterior-posterior position of the maxilla and the mandible. The age 4 vertical arc assesses the lower vertical height of the mandible at age 4, and the age 18 vertical arc assesses the lower vertical height of the mandible at age 18 and older.

To establish the anterior arc, place the metal point of the compass on Center “O” and place the marking point of the compass on N (nasion). Draw an arc from Nasion down past the soft tissue of the chin. To establish the vertical arcs, take the metal point of the compass and place it on ANS (anterior nasal spine) and place the marking point of the compass on SO (supraorbital). Rotate the compass down toward the menton area and strike a small arc. This will be the age 4 vertical arc. Now increase the compass by 10mm using a millimeter ruler and strike another short arc. This will be the age 18 vertical arc.

Interpretation of the Skeletal Archial Analysis is very simple. In ideal anterior-posterior skeletal position, ANS of the maxilla and pogonion of the mandible should be within 2mm of the anterior arc. In so doing, both the maxilla and the mandible are in correct relationship to each other, but more importantly, they are in correct relationship to the cranial base. In ideal lower facial vertical height position, menton should be on the age 4 vertical arc when patients are four years old. Menton should be on the age 18 vertical arc when patients are 18 years old or older. From age four, the lower face increases in vertical height at the rate of .75mm (.04mm) per year until age eighteen. It is conceivable that by using this calculation, we can determine the correct lower facial vertical of our patient almost to the millimeter.

In the tracing of an actual female patient who was exactly 12 years old in Fig. 15, it can be seen that her ANS is exactly on the anterior arc which is ideal. However, her pogonion sits behind the anterior arc and is clearly retrognathic. In the vertical assessment, her menton is just a little longer than the age 4 vertical arc, but is not long enough to reach age 12 vertical. The age 12 vertical was determined by subtracting age 4 from age 12 which equaled eight. Eight years times .75mm equaled 6mm. Hence, there should be 6mm of growth in 8 years from the age 4 vertical arc.

Fig. 15: Female patient, 12 years old.
Based on the Skeletal Archial Analysis, this patient has a normal maxillary position. However, her mandible is retrognathic and she is skeletally short. To treat this patient to ideal proportion which will enhance her facial profile, alleviate potential TMD problems and physiologic problems, her mandible should be repositioned forward closer to the anterior arc and menton should be lengthened closer to her age 12 vertical. In the proposed skeletal classification system which will be explained later, her skeletal classification is Skeletal Type IIB, Short.

**Skeletal classification system**

The Skeletal Archial Analysis is accurate and helpful in assessing facial-skeletal disharmony. This is based on hundreds of cephalometric tracings, diagnoses, and treatments rendered in my office. Even so, any cephalometric analysis, including this one, should be viewed as one of many diagnostic evaluations to be used in assessing specific treatment modalities for individual treatment. However, because it is appropriate and easy to use, the proposed skeletal classification system will be based on this analysis.

The nomenclature for the proposed skeletal classification of malposition will be somewhat analogous to Angle’s dental classification of malocclusion. Dr. Angle so clearly defined and illustrated ideal dental occlusion as well as various types of malocclusion with his publication that his concept has become firmly entrenched in the minds of all orthodontic practitioners even to this day. His observations have been accurate and have withstood the test of time. More importantly, it is universally accepted because it applies to all individuals, regardless of race, age, sex, and other variabilities.

Similar to dental classification of Class I, II, and III, the skeletal classification will be designated Type I, II, and III. However, because the maxillary and the mandibular position will be in relation to the cranial base, maxillary malposition will be designated A, mandibular malposition will be designated B, and a combination of maxillary and mandibular malposition will be designated C. Additionally, if the maxilla and the mandible are both malpositioned behind the anterior arc, the skeletal nomenclature will be bi-skeletal retrognathism or BR. If the maxilla and the mandible are both malpositioned in front of the anterior arc, the skeletal nomenclature will be bi-skeletal prognathism or BP.

In order to understand how the Skeletal Archial Analysis is used in determining patients’ skeletal classification, a skeletal diagram is shown in **Fig. 16**. The curved vertical arc in front of the two arrows represents the anterior arc of the Skeletal Archial Analysis. The top arrow, designated A, represents the maxilla. The lower arrow, designated B, represents the mandible. The tip of the arrow point A represents ANS, and the tip of the arrow point B represents pogonion. Since both arrow points are touching the curved vertical arc, this skeletal diagram indicates that this patient has ideal maxillary and mandibular A-P position. If the vertical assessment of this patient was found to be normal, then this patient’s skeletal classification would be Skeletal Type I, Normal.

As practitioners become more proficient in using the Skeletal Archial Analysis, they will begin to see myriads of facial-skeletal problems that they may not have been aware of previously. Most practitioners currently do not see certain types of facial-skeletal disharmony because most analyses are mainly concerned with upper jaw-lower jaw relationship, but do not adequately address the maxillary and mandibular relationship to the cranial base. The Wits analysis is an excellent method of assessing A-P relationship of the maxilla and the mandible to each other, but does not assess their position relative to the cranial base. Why is the assessment of the maxilla and the mandible relative to the cranial base so important? Because it has tremendous impact on the patients’ facial esthetics, TMJ health, and physiologic harmony. All this really goes back to the basic understanding of the divine proportion.

The skeletal diagram as shown in **Fig. 17** shows the various types of skeletal malposition that may be found in the general population. Skeletal Type I is ideal maxillary and mandibular skeletal position. Not only are the maxilla and the mandible perfectly related to each other with respect to A-P position, they are also perfectly related to the cranial base. Skeletal Type IIA is defined as the maxilla being prognathic to the cranial base and the mandible as being in normal A-P position to the cranial base. Type IIB is defined as the maxilla being in normal A-P position and the mandible as being retrognathic. Type IIC is defined as the maxilla being prognathic and the mandible being retrognathic; it is a combined problem. Skeletal Type IIIA is defined as the maxilla being...
retroganhatic and the mandible being in normal A-P position to the cranial base. Type IIIB is defined as the maxilla being in normal position to the cranial base and the mandible being prognathic. Type IIIC is defined as the maxilla being retrognathic and the mandible being prognathic; it is a combined problem.

Skeletal Type BR (bi-skeletal retroughatism) is defined as both the maxilla and the mandible being retrognathic to the cranial base. Skeletal Type BP (bi-skeletal prognathism) is defined as both the maxilla and the mandible being prognathic to the cranial base. The various types of skeletal malposition with their designated nomenclature are clearly illustrated in the skeletal diagram of malpositions.

Although the skeletal nomenclature and diagram refers to anterior-posterior relationship of the maxilla and the mandible to the cranial base, it must be emphasized that the vertical position of the mandible must also be assessed and identified. Just as maxillary and mandibular A-P malposition can create problems, vertical malpositions can also create enormous esthetic and physiologic problems as well. The following example is given to show how to assign the correct skeletal classification nomenclature. If the Skeletal Archial Analysis shows that the maxilla is in normal position, the mandible is retrognathic, and the lower facial vertical height is short as shown previously in Fig. 15, then the correct skeletal classification is Skeletal Type IIB, Short. If on the other hand, this analysis showed that the lower facial vertical was long, then the correct skeletal classification is Skeletal Type IIB, Long. If the vertical is normal, then it is designated Skeletal Type IIB, Normal. Skeletal Verticals can be normal, long or short in Skeletal Type I, II's, III's, BR, and BP.

Practical application of skeletal classification system

Many studies and articles have attempted to describe ideal facial esthetics. Broadbent, 76 Peck and Peck, 77 Burnstone, 78 Bowbeer, 79 and Mew, 80 for example, have published on this very important topic. Many have stressed the importance of visual soft tissue assessment for facial esthetics. However, Peck and Peck state that cultural biases can create aberrant esthetic preferences. For example, they warn that “if all of us began practicing indiscriminate extractions on all patients, surely we would soon perceive a new ‘beauty’ in the ‘dished-in’ profile.” Fortunately, Ricketts stated that we are all endowed with the innate ability to appreciate faces and forms that must satisfy strict criteria of ideal balance and harmony. In a universal setting, this will always take precedent over any fad or cultural bias. One of the treatment objectives of orthodontic/orthopedic therapy is to treat patients toward improved facial appearance. In order to accomplish this, practitioners must be able to assess accurately facial-skeletal disharmony and to understand ideal facial-skeletal position.

The position of the facial-skeletal structures has a tremendous impact on the ultimate appearance of the face and on the physiologic harmony of the patient. The ultimate goal of the orthodontic/orthopedic practitioner is to treat patients toward ideal facial-skeletal position which will maximize facial esthetics and physiologic harmony. The Skeletal Archial Analysis with its corresponding skeletal classification system is an excellent method to aid in the assessment of skeletal malposition. It clearly directs where the skeletal problem lies, whether it is in the maxilla, mandible, or both. Additionally, it will tell you if the maxilla and/or the mandible is too far back or too far forward relative to the cranial base, or if the lower facial height is too short or too long. There appears to be no other analysis to date that can give you this much information so quickly and so accurately. More importantly, this analysis is based on ideal biologic proportion which is directly related to the divine proportion.

No matter what the skeletal malposition may be, the ultimate goal of the practitioner is to treat the patient as close to Skeletal Type I, normal vertical as possible. To illustrate clearly the practicality of the Skeletal Archial Analysis and the proposed skeletal classification system, several case reports will be presented. The first case report will show a patient with ideal facial esthetics and profile. The other case reports will show various types of skeletal malpositions.

Case report #1, Figs. 18 and 19, shows what I felt had nearly all the criteria for an ideal face. By clearly illustrating ideal facial form and profile, I offer a visual model that can be used as reference. See Fig. 18. Furthermore, by showing actual cephalometric tracing, it can be seen that the Skeletal Archial Analysis accurately reflects the soft tissue profile. See Fig. 19. This analysis clearly shows that this patient’s maxilla and mandible are in ideal A-P and vertical position. By developing toward these ideal positions, this patient has achieved maximum facial esthetics and physiologic
Case Report #2, Figs. 20 and 21, shows a patient with short face syndrome. As can be seen in Fig. 20, a patient with short face syndrome does not have ideal facial proportion and balance which can have a negative effect on facial esthetics. The Skeletal Archial Analysis in Fig. 21 accurately reflects the skeletal position of this adult female patient. Her A-P position of the maxilla is normal. However, this patient’s mandible is overclosed by approximately 19mm. The counter-clockwise rotation of her mandible due to her overclosure causes her mandible to jut forward and ahead of the anterior arc. Her skeletal classification is Skeletal Type IIIB, Short. This is a pseudo Type III situation because if she were treated to her correct vertical, her mandible would rotate clockwise to a more normal Skeletal Type I position. This patient suffered from severe TMD and other physiologic problems.

Case Report #3, Figs. 22 and 23, shows a female patient, age 16 years-7 months, with long face syndrome. As can be seen in Fig. 22, a patient with long face syndrome does not have ideal facial proportion and balance which can negatively affect facial esthetics. The Skeletal Archial Analysis in Fig. 23 accurately reflects her soft tissue profile. The A-P relationship of her maxilla is in normal position. However, her mandible juts forward ahead of the anterior arc and it also extends below the age 18 vertical arc. Her skeletal classification is Skeletal Type IIIB, Long. This patient suffers from severe nasal airway obstruction. Many clinicians and researchers have attributed mouth breathing as the primary cause of long face syndrome. Physiologic problems are associated with facial-skeletal disharmony. Case Reports #2 and #3 are prime examples of such direct correlations.
Case #4, Figs. 24 and 25, shows a female patient, age 13 years-1 month, with a short face syndrome. As can be seen in Fig. 24, she does not have ideal facial proportion and balance. The Skeletal Archial Analysis in Fig. 25, accurately reflects her soft tissue profile. Her maxilla is retrognathic, and her mandible is prognathic (due to her short vertical). This is a combination A-P problem. Her skeletal classification is Skeletal Type IIIC, Short. This patient suffered from constant and chronic headaches.

It is important to note that this patient is not a surgical case. This patient was treated with a bionator to open. By skelettally increasing her vertical, her mandible rotated in a clockwise rotation which brought it closer to a Skeletal 1 relationship. The retrognathic maxilla was brought forward closer to ideal position with an anterior push sagittal. The treatment was finalized with straight-wire fixed appliance therapy.

Case Report #5, Figs. 26 and 27, shows a female patient age 8 years-10 months. This patient’s facial profile and balance is not ideal. Her Skeletal Archial Analysis accurately reflects her soft tissue profile. Her maxilla is in ideal A-P position; however, her mandible is significantly retrognathic and she is skelettally short. Her skeletal classification is Skeletal Type IIIB, Short. A patient with this type of facial-skeletal disharmony has an almost 100 per cent chance of developing temporomandibular disorder. Repositioning her mandible in a more ideal position via functional appliance therapy would offer this patient tremendous benefits in esthetics, TMJ health, and physiologic harmony.
Discussion

Much of what has been said may sound theoretical and may even go against ideas and philosophies that were taught in dental schools. However, they are based on years of clinical observations which seem to support the universality of facial beauty and divine proportion. The concept of a universal standard for facial beauty evolved when it became apparent that all my orthodontic patients regardless of race, age, sex, and other variabilities were being treated toward the same classic profile.

Cephalometric analysis is helpful in assessing facial-skeletal malpositions. However, analyses such as those done by Tweed, Downs, and Steiner concentrated too much on assessing dental problems and not enough on skeletal problems. Furthermore, they often had different values for different segments of the population. These disadvantages ultimately led me to the Sassouni Archial Analysis.

The Sassouni Archial Analysis, published in the 1950’s, was ahead of its time. It assessed facial-skeletal malpositions at a time when our profession did very little skeletal corrections. However, it became complicated and confusing to use when it also attempted to assess dental problems as well. Eventually, I developed a simpler and more streamlined version of this analysis, the Skeletal Archial Analysis, to specifically assess skeletal problems and to help determine the skeletal classification.

Cephalometric analysis as well as soft tissue assessment, TMJ evaluation, and physiologic consideration should be used to obtain accurate diagnosis. By treating patients to the correct facial-skeletal position based on these criteria, there will occur a beneficial “domino effect” in over 90 per cent of the cases. The first benefit is improved facial and dental esthetics; this is followed by alleviation of any TMD symptoms. Ultimately, various medical symptoms will improve.

As stated previously, patients with short face syndrome seem to have a higher incidence of TMD. By increasing lower facial height which enhances facial harmony, the joint spaces increase to a healthier position, and symptoms of migraine headaches often improve. Patients with long face syndrome seem to suffer from nasal airway obstruction and tend to be mouth breathers. Hershey, Stewart & Warren, Turbevill, and Hartgenfink and et al. found that by expanding the palate which widens the sinuses, nasal respiration often improves.

Finally, the skeletal classification system evolved out of necessity to describe the multitude of facial-skeletal problems that were becoming evident while using the Skeletal Archial Analysis. In some cases, new problems never previously described such as Skeletal Type IIIC, Short, were being discovered. The beauty of both systems, the Skeletal Archial Analysis and the skeletal classification system, is the simplicity and ease by which they can be used. They indicate whether the skeletal A-P discrepancy is in the maxilla, mandible, or both. Just as important, they indicate whether there is a vertical problem.

The Skeletal Archial Analysis and the skeletal classification system do not provide information on maxillary and mandibular width and facial asymmetry. If desired, these two designations can be added to the skeletal classification system; for example, Skeletal Type IIB, Short, Narrow Mx, Asymmetry Mn L. A patient with this skeletal classification would have a normal maxillary A-P position, a retrognathic mandible, skeletally short vertical, narrow maxilla, and facial asymmetry where the mandible shifts to the left. The ultimate treatment goal is to treat patients as close to Skeletal Type I, normal vertical as possible.

Although diagnosis and treatment of skeletal problems are emphasized, the treatment of dental problems must also be addressed. In most instances, correction of skeletal problems helps resolve many dental problems. A perfect example is dental crowding due to a constricted maxillary arch. Major crowding can be corrected with palatal expansion which creates room to allow the dentition to unfurl and to begin aligning more ideally. The balance of the dental problems can be corrected with fixed appliance therapy. Many other dental problems are more easily corrected when the skeletal problems are first resolved.

Summary

In random studies, some faces will deviate toward Type II skeletal and some toward Type III. Some will deviate toward a skeletally short vertical while some toward long. In their study, Langlois and Roggman digitized individual faces through a computer. As more
and more faces were entered, the composite of these faces became more and more attractive. From this, they concluded that attractive faces are only average. The "average" face may very well conform to the divine proportion. However, some faces are strikingly beautiful, and Alley and Cunningham\textsuperscript{92} in their study attempted to explain these attributes.

Individuals who are blessed with attractive features are treated differently in our society. Ackerman\textsuperscript{93} states, "Attractive people do better: in school, where they receive more help, better grades and less punishment; at work, where they are rewarded with higher pay, more prestigious jobs and faster promotions; in finding mates, where they tend to be in control of the relationship and make most of the decisions; and among strangers, who assume them to be more interesting, honest, virtuous and successful." Many would find this special treatment objectionable and unfair. The irony is that beautiful individuals make up a very small percentage of the population; they have very little power to dictate how society should act and behave.

Various disciplines have studied the nature of facial beauty. Individually, they provide partial answers; however, when viewed together, they begin to weave provocative insights as to its biologic significance. It is intricately related to divine proportion, and all living creatures have the genetic potential to develop toward it. The appreciation for this proportion is primitive and inborn; it is a biologic mechanism by which all living creatures are attracted to potential mates who conform to this strict proportion because they are biologically strong, healthy, and fertile.

To date, there is no other profession other than ours that has the knowledge and the expertise to treat facial problems. We have a keen interest in facial and dental esthetics. We understand occlusion, TMJ anatomy, and facial-skeletal relationship to soft tissue profile. Unlike plastic surgery, where the soft tissues are artificially recontoured for better esthetics, we can make real and substantial skeletal changes. We are able to correct the architectural framework of the face to its physiologically correct position. In so doing, we cannot only improve our patients' appearance, but improve their health as well.

There are those in our profession who are afraid of changes. They will not accept what has been presented with the usual excuse that they are "anecdotal" and not supported in the scientific world with rat and monkey studies. Although the concepts presented are complicated and controversial, I have attempted to present them clearly and simply with many references. There will be those, however, who will stubbornly continue to disbelieve the efficacy of functional appliance and TMD therapy even though in the real world there are many successes with human patients. With time, the truth will become self-evident.

Finally, it is not my intent to say that everyone should look alike. Superficial variations and differences appropriate to certain climatic conditions and other environmental factors are often necessary for the survival of the species. Additionally, in rare instances, some Skeletal Type II individuals have shorter mandibles than normal. To reposition these mandibles forward closer to the anterior arc may create a "dual" bite situation. In other rare instances, Skeletal Type III individuals may have longer mandibles than normal. To reposition these mandibles posteriorly closer to the anterior arc may cause impingement of TMJ spaces and TMD.

As more and more information is gathered, it is becoming clear that the physical, emotional, and psychological health of our patients are intimately related to the cranio-mandibular anatomy. Individuals with facial disharmony are often ridiculed and ostracized. The damage to their self-image and self-worth can create an impenetrable barrier to their ultimate self-realization and self-fulfillment.\textsuperscript{94} By correcting problems closely associated with the human psyche — the human face — we can help them achieve equal opportunities for health, happiness, and success. There can be no greater gift than this to bestow on another human being. Our greatest challenge today is having the courage to seek the truth, understanding the enormity of our professional capabilities, and being humbled by it. As John Ruskin once wrote, "The highest reward for man's toil is not what he gets for it but what he becomes by it."

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