REVIEW ARTICLE

GROWTH ASSESSMENT PARAMETERS- AN UPDATE

ABSTRACT

It is important to know the stage of maturation of a patient. Assessing maturational status, whether the pubertal growth spurt of that patient has been reached or completed, can have a considerable influence on diagnosis, treatment goals, treatment planning, and the eventual outcome of orthodontic treatment. This is especially true when clinical considerations are based strongly on the increased or decreased rates of craniofacial growth, such as the timing and use of extra oral traction, the use of functional appliances, extraction vs. non-extraction, the selection and execution of orthodontic retention, and the timing of orthognathic surgery. It is a great challenge therefore to diagnose and to plan an ideal treatment for the cases keeping in mind their growth potential, the present article reviews about the various methods of assessing the growth.

Key words: growth assessment, maturation, parameters

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INTRODUCTION

Assessing maturational status, whether the pubertal growth spurt of that patient has been reached or completed, can have a considerable influence on diagnosis, treatment goals, treatment planning, and the eventual outcome of orthodontic treatment.[1]

This is especially true when clinical considerations are based strongly on the increased or decreased rates of craniofacial growth, such as the timing and use of extra oral traction, the use of functional appliances, extraction vs. nonextraction, the selection and execution of orthodontic retention, and the timing of orthognathic surgery.[2]

The growth and development of the human face provides a fascinating interplay of form and function. The mosaic of the morphogenetic pattern, as it is influenced by epigenetic and environmental forces, requires an understanding of many factors if we are to fully appreciate the phenomenon.

Of the same chronological or calendar age have led to the concept of biologic or physiologic age. Physiologic age is the registry of the rate of progress toward maturity that can be estimated by somatic, sexual, skeletal, and dental maturity.[3]

Why to assess growth ?

The clinician is interested in assessing physical growth for the following reasons :

a) The identification of grossly abnormal pathologic growth.

b) The recognition and diagnosis of significant deviation from normal growth.

c) The planning of therapy.

d) The determination of efficacy of treatment.

William Hirschfield and Robert Moyers (1971)[3]

Several predictive methods are used in industry and science. We may group these under following headings.

1. Theoretical

2. Regression

3. Experimental

4. Time series

Theoretical Methods of Prediction:

Theoretical models of cranio facial growth have not yet been defined mathematically in terms precise enough to permit the application of the method to prediction.

Regression Methods:[3]

These methods serve to calculate a value for one variable called dependent, on the basis of its initial states and the degree of its correlation with one or more independent variables.

Johnston has recently evaluated and reviewed regression methods of approach to craniofacial prediction. Among his conclusions is that:

(1) The ultimate accuracy of cephalometric predic-

tion may be limited to some extent by intrinsic errors with the cephalometric method itself.

(2) Contemperory methods seem inadequate to provide an efficient estimate of individual changes attributed only to growth. Burstone has reviewed some of th problems of attack and of selection of independent variables with regard to growth prediction. [4,5]

Experimental Methods:

Experimental methods are based on the clinical experience of a single investigator who attempts to quantify his observations of practice in such a way that they can be qualified for use by others. The best known example of the experimental method in craniofacial growth prediction is that of Ricketts, whose estimates of growth prediction for the individual utilize means derived from a large sample of treated orthodontic patients. The method is popular and widely used, but its theoretical base is shaky on two counts. First the assumption must be made that the individual being predicted will behave as the mean of a population of which he is not a member. Second, the morphology of the mandible and the other parts is a clue to the future growth of the face, appoint disputed by Horowitz and Hixon, Balbach and Woodside. [5]

Time Series Method:

Because of the great interest in prediction of craniofacial growth and the limitations of the methods thus far tried, it seems pertinent to ask whether there might be some other method of prediction, as yet, untried on growth problems which would provide the desired accuracy, efficiency and individuality for the clinician.

Operations research has been concerned with the development of methods which are based on individual not population behaviour.

The methods are essentially two types:

1. Time series analysis which extracts in a mathematical form the fundamental nature of the process as it relates to time.

2. Smoothing methods, either moving averages or exponential, which operate to give representative or average values to the parameters of a previously derived time series equation .For pur-

pose of analysis a time series is considered to be composed of four parts. These are

1. Trend or long term movement
2. Oscillations about a trend
3. Cyclic or periodic events
4. Random compliments

The analysis consists of assessment of each of these parts by means of specific statistical tests. Time series method offers more promise for craniofacial growth than any of the methods thus far used. [6]

METHODS OF STUDYING PHYSICAL GROWTH[3]

There are two basic approaches for studying physical growth

1. Measuremental approaches
2. Experimental approaches

Measuremental approaches

It is based on techniques for measuring living animals, with the implication that the measurement itself does no harm and that the animal will be available for additional measurements at another time.

The science of physical anthropology began with craniometry, which is based on measurements of skulls found among human skeletal remains. From these skulls. It has been possible to piece together a great deal of knowledge about extinct populations and to get some idea of their pattern of growth. Its advantage is that rather precise measurements can be made on dry skulls. Its disadvantage is that all study is cross sectional. [7]
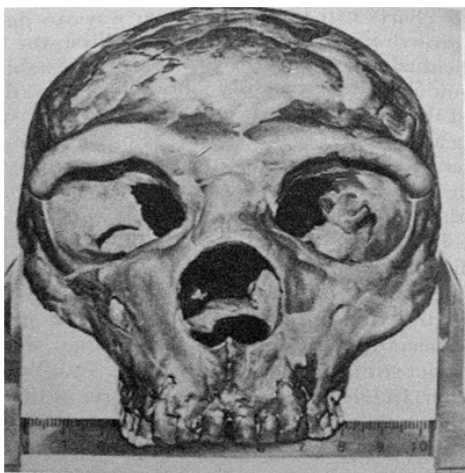
(Fig 1: Measurements taken on skull.) [7]

CRANIOMETRY[7]:

Craniometry is the technique of measuring the bones of the skull. It is distinct from phrenology, the study of personality and character, and physiognomy, the study of facial features. However, these fields have all claimed the ability to predict traits or intelligence.

They were once intensively practiced in anthropology, in particular in physical anthropology in the 19th and the first part of the 20th century. Theories attempting to became popular at this time, one of their prominent figures being Georges Vacher de Lapouge (1854-1936), who divided humanity into various, hierarchized, different "races", spanning from the "Aryan white race, dolichocephalic" (from the Ancient Greek kephalê, head, and dolikhos, long and thin), to the "brachycephalic" (short and broad-headed) race.

Historians study the influence and caution that science provided for racially divisive ideologies in the late 19th and early 20th century, at the height of the New Imperialism period. On the other hand, Charles Darwin used craniometry and the study of skeletons to demonstrate his first expressed in On the Origin of Species (1859).

A large skull meant a large brain and high intellectual capacity, and a small skull indicated a small brain and decreased intellectual capacity. By studying these skulls he decided at what point Caucasians stopped being Caucasians, and at what point Negroes began. Morton had many skulls from ancient Egypt, and concluded that the ancient Egyptians were not African, but was White. Later studies have since proven that this idea is false by all accounts. While few still believe it, his name has fallen into obscurity quite deeply simply because of his biased views.

It's also possible to measure skeletal dimensions on living individuals and it's called as anthropometry. It disadvantage is that soft tissue introduces variation. But on the other hand it has an advantage that it makes it possible to follow the growth of an individual directly or longitudinal study can be carried out. [2]

The third measurement technique, cephalometric radiology, combines the advantages of craniometry

and anthropometry

Experimental approaches [3]

Vital staining is a technique in which dyes that stain mineralizing tissues /soft tissue are injected into an animal. The great English anatomist originated this method, John hunter in the eighteenth century. Alizarin and tetracycline are example of vital stains.

Radioactive tracers: It has been possible to use almost any radioactively labeled metabolite that becomes incorporated into the tissues as a sort of vital stain. 99mTc can be used.

Rapid advances in molecular genetics are providing new information about growth and its control. For example transforming growth factor beta-gene now is known to be important in regulating cell growth and organ development.

Another experimental method is implant radiography. In this technique inert metal pins are placed in bones anywhere in the skeleton. Professor Arne Bjork and coworkers developed this method of study. Precise evaluation of dentofacial growth in humans still is done best by implant radiography.

Relevance of growth in orthodontics:

It's difficult to comprehend conditions observed in adults without understanding of the developmental process that produced these problems. So a thorough knowledge of growth is needed.

To distinguish between normal variation from the abnormal. We need to know the normal growth pattern.

Orthodontics are 'Orthopedic Surgeon" of the craniofacial complex and are involved in the development of not just dentition but he entire dentofacial complex.

It will be easier to answer the following questions if we have thorough knowledge of growth

❖ Can something be done to a maxillary and mandibular growth to eliminate the dental malrelationship?

❖ Can we stimulate deficient jaw growth?

❖ Can we retard growth of one jaw in hope of gaining adjustment?

❖ Can we change the direction of growth?

In short, we can say that:

Treatment time, Treatment method, tooth position changes, decisions on extractions, ultimate prognosis and stability all depend on thorough knowledge of the process of growth. Some of the methods commonly used for this purpose are described here.

Frontal Sinus Development as indicator of puberty[8,9]

Sabine Ruf and Hans Pancherz (1996) evaluated the development of the frontal sinus to the longitudinal data of the subject's growth charts. Results showed that Frontal sinus growth velocity at puberty is closely related to body height growth velocity. Frontal sinus shows a well defined pubertal peak (Sp), which on an average, occurs 1.4 years after the
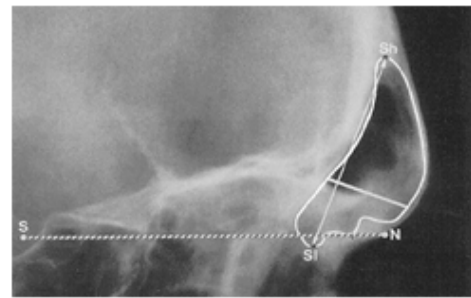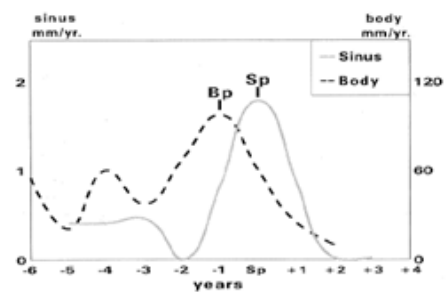

Fig:2 : Lat ceph. and graph
showing growth pattern of frontal sinus. [8]

pubertal body height peak. (Bp).If the only prediction was that whether pubertal growth maximum has passed the precision of this method was high (90 %).But if incidence of body peak was to be predicted the accuracy is only 55%.Moreover, it is only possible if 2 cephalograms approximately 1-2 yrs spaced, of the same individual are available.

DENTAL AGE[10]:

Evaluation of the dental status is of great importance for the prognostic assessment of dental development.

Chronologic and dental ages are synchronous in the normal patient. A child is labeled as an early or late developer if there is a difference of +- 2 years from the average value. If the chronologic age of the patient is younger than the dental age, one can rely on increased growth to a greater degree than when dental age is retarded in relation to the chronologic age (and possibly biologic age).

Dental age can be determined by two different methods;[10]

-stage of eruption

-stage of tooth mineralization on radiograph.

Stage of eruption:

Determination of dental age from observation of eruption has been the only method available for a long time. In most instances, it is fairly reliable. In certain cases, however, the accuracy of the method is limited. During the quiescent periods in eruption, this approach is inadequate.

Stage of tooth mineralization on radiograph:

When determining dental age radiographically according to the stage of germination, the degree of development of individual teeth is compared to a fixed scale. [10]

For age determination, one does not rely on the last stage of tooth formation but on the entire process of dental mineralization. This renders the estimation of age more accurate. The procedure can be used for the entire deciduous and mixed dentition period, and is not influenced by early loss of deciduous dentition. The calculation is made using a point evaluation system (Demirjian et al. 1973, Schopf 1970). Each tooth is given a point value according to its state of development. The sum of individual points gives the developmental value, which can be transferred into the dental age with the aid of standard tables. The smaller the sum of points, the younger is the dental age; the higher the sum the older the dental age. [2]

BJORK'S CONTRIBUTION TO IMPLANT STUDIES AND FACIAL GROWTH[11]

Arne Bjork- The Man and his Work.

Arne Bjork is internationally known for his contributions to the understanding of craniofacial growth. His early publication, The Face in Profile, 1947, made him known all over the world. Bjork practiced as a clinician in Sweden for 14 years before moving to Denmark in 1951, where he chaired the Dept of Orthodontics, Royal Dental College, Copenhagen. There, Bjork combined the methods of metallic implantation and serial cephalometric roentgenography, to unravel the secrets of facial growth. His sample consisted of children attending the Department of Orthodontics, who were willing to take part in the study. Around 100 persons of each sex were included in this study, having different types of malocclusions, and ranging from 4-25 years of age. The implant method was used and annual radiographs were obtained from childhood to adulthood. The systematic superimposition of these serial radiographs with the help of implants form the basis of Bjork's studies. The results of these studies have been published in the major American and European journals since the 1950s and have become classics on the subject of facial growth.

Method and application of the use of metallic implants: [11]

Small pins of hard tantalum are hammered into bone under local analgesia with a special pencil-shaped instrument in which the implant is placed. The tantalum pins are more radiopaque than chrome cobalt alloy and retain their position in bone well. These measure 1.5mm in length and 0.5mm in diameter. A smaller pin has also been designed, measuring 1.2 x 0.37 mm. The instrument is made of stainless steel and has a hard, replaceable tip, into which the pin fits. The instrument is pressed through the periosteum to secure a firm basis before the pin is hammered in.

❖ Sites for Implant placement[12,13]

The mandible:

Before the pins are inserted, the form of the mandible and position of the dental germs are studied on the profile radiographs. Usually, 5 or 6 pins are inserted in 4 regions.

Region 1: One pin is placed on the anterior aspect of the symphysis, as low down as possible in the midline beneath the germs or root tips. This pin has proved to be highly stable, but may be exposed by resorption, if placed too high in the supramental region.

Region2: Two pins are inserted on the right side of the basal part of the mandible, under the 1st premolar and 2nd premolar (or 1st molar), beneath their germs or root apices.

Region 3: One pin is placed on the external aspect of the right ramus, on a level with occlusal surfaces of the molars. This may be gradually exposed by resorption and a new one needed.

Region 4: One or two pins are also inserted in the mandibular base on the left side, under the 2nd premolar or 1st molar. (By using small pins on the right side and larger ones on the left, they can be recognized easily.)

The Maxilla:

There are 4 regions in which implants are unlikely to be disturbed. It is usual to use six implants, preferably small ones on the right side.

Region 1: Before eruption of permanent incisors, pins are inserted, one on each side of the hard palate, behind the deciduous canines, near the median plane of the face. (Their stability depends on the extent to which the nasal floor is lowered by resorption process.)

Region 2: After eruption of the permanent central incisors, an implant is placed on each side of the median suture, below the anterior nasal spine.

These are useful for analyzing sutural growth of upper face in sagittal plane as well as transverse growth of maxilla. On each side of the head.

Region 3: At an early age, two implants can be placed in the zygomatic process of the maxilla. In order not to be disturbed by erupting teeth, these must be placed lateral to the alveolar process. Occasionally when there is a thin bone wall and maxillary sinus increases greatly during growth, one implant may be lost through the nose.)

Region 4: Implants have also been placed with good results at the border of the hard palate and the alveolar process, medially to the 1st molar.

It is standard technique to insert pins in both jaws as described. [14]

Radiographic Method [15]:

Reproducibility of head positioning in the cephalostat is very necessary in implant studies.Any discrepancies in this procedure from year to year will result in differences in projection, causing large and unacceptable errors.Bjork used a specially designed X-ray cephalostat with a built-in 5" image intensifier which would enable the position of the head to be monitored by television.

Evaluation of facial growth using serial radiographs [16]:

In order to avoid the errors associated with the tracing procedure, a printer called the Log-Etronic printer combined with an enlarger is used.By copying superimposed films by the Log-Etronic technique, a picture of the growth of the face or of a single jaw is obtained in a lateral view. These pictures are obtained by superimposing the positive films of the radiographs to be compared and making a negative Log-Etronic film of the superimposed films.

Clinical significance: [2]

1. Treatment involving modification of skeletal growth seems to demand as much as information as possible about patient's growth potential.

2. Orthodontic appliances such as the mandibular protraction appliance, Herbst appliance, Frankel, Bionator, Twin block and activator.

3. In cases where patient require orthopedic changes using head gears and protraction masks.

4. rior to rapid maxillary expansion.

5. In patients with marked discrepancy between dental and chronological age.

6. Orthodontic patients requiring orthognathic surgery if under taken during growth period.

7. When maxilla mandibular changes are indicated in the treatment of class III cases, skeletal class II cases or skeletal open bites.

CONCLUSION

As we dentists nowadays deal with more and more

of mixed dentition cases, many of whom may or may not present with a skeletal malocclusion.

It is very important for us to determine the magnitude and direction of growth if we are to treat these cases with a fair amount of success.

It is a great challenge therefore to diagnose and to plan an ideal treatment for these cases keeping in mind their growth potential.

The above mentioned studies were attempts made by various people in order to ascertain the type of growth in their patients and set forth guidelines for us to follow.

However we should not forget that every individual is unique in his own aspect and therefore we should not jump to conclusions but study our patients over time and treat them to their individual requirements.

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