

Analysis of Encroachments on the Constitution*

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Registration of gains in height, weight and physical maturity are obviously significant in estimating the rate of growth in a growing child. Fluctuations in the density of bone muscle and subcutaneous tissue, as seen on the X-ray, are delicate indicators of health.

Temporary illness even when severe does not always result in laggard growth, whereas a child, handicapped by some chronic disability such as hypothyroidism or severe allergy, does not achieve the expected increment in stature. Month by month and year by year he falls farther and farther behind.

Laggard growth is seen not only in the bones of the trunk and limbs but in the bones of the face as well. The face grows in three directions: vertically, horizontally and anteroposteriorly. Facial growth may be unequally retarded. There is the narrow pinched face of the gastro-intestinal allergic where lateral growth is more retarded than vertical. This defect is all too frequently laid to adenoids, but adenoid overgrowth is the result of congestion in cramped nasal passages and is not the cause.

If the vertical growth is defective the hard palate becomes uptilted at the anterior end instead of remaining horizontal. The nasal septum may buckle, leading to the formation of spurs and a deflected septum, if vertical facial growth is not proportionate to growth in the bony framework of the nose. Long-standing congestion of an inferior turbinate may cause the septum to become bent or bowed. The palate with a very narrow high arch is also the result of imperfect facial growth.

If the jaw growth is retarded the teeth cannot erupt in proper alignment. It is quite obvious that defective facial growth is the background for a very large proportion of orthodontic problems. All too frequently treatment is not sought until the distortion is extreme. The problem is then one of salvage. If the beginning stages can be identified the problem is one of restoration to normal.

Acute illnesses do check growth temporarily but do not materially affect the increment of growth during a six to twelve-month period. Scars of interrupted growth appear on X-rays as white transverse bands near the end of the shaft. In illness the cells at the growing end of a bone cease for a short time to proliferate new bone. The result is a piling up of building

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material which causes a band of increased density. After the illness ossification is resumed and bone of average density is laid down beyond the dense band. The scar persists for one or two years but ultimately disappears and leaves no trace on the subsequent X-rays.

Scars of interrupted growth are analogous to the defects seen in hypoplastic enamel. There are to be sure two important distinctions. The marks on the bones are not permanent and the growing ends of the bones are much more sensitive. Illnesses producing defects in the enamel must be quite severe. There are many illnesses which produce bone scars but which leave no visible marks on the teeth.

There is no constant relationship between the severity of the illness and the definiteness of the resultant scar. If the child is in excellent physical health he may suffer rather severe illness without any interruption in growth. In a child already somewhat below par a comparatively mild illness may produce a definite scar. It is difficult to estimate the constitutional effect from the clinical symptoms. The scar seen on the X-ray does give us a measure of the shock to the constitution.

The scar of interrupted growth, appearing as a well-defined white band extending transversely across the entire width of the shaft, must be clearly distinguished from another type of growth interruption, namely that producing bone scorings. Scorings are delicate transverse lines of increased density also appearing near the ends of long bones. They are multiple, extend only part way across the shaft and are most frequently seen on the distal end of the tibial shaft but are also common at the lower end of the radius, the upper end of the tibia and the lower end of the femur. They are the result of certain subclinical and repeated disturbances causing some interruption to growth but not severe enough to produce actual scarring. Scorings are definite evidence that the child is suffering a metabolic handicap even though the child is not "clinically" sick.

In this laboratory an exhaustive study has been made of the ossification of epiphyses and a definite schedule for order of appearance has been established. The mechanism which causes a given epiphysis to produce bone at a certain time is extremely sensitive. Any illness or metabolic upset may prevent initial ossification and if this process has once been delayed it may be months or even years before that epiphysis begins to ossify. Epiphyses, in which ossification has begun before the setback, go on developing normally, and also those epiphyses which are scheduled to begin ossification after recovery, ossify on time. In other words, a missing center of ossification means an illness at the time when that center would normally begin to change from cartilage to bone. It might be likened to a time clock registering the time of the illness as well as its constitutional effect.

From our X-ray standards of development it is possible to assess accurately the developmental age of an individual from roentgenograms of the skeleton. Children free from disease and vigorous in mind and body tend to be advanced in bodily maturity. This advance is apparent by one year of age. During the grade-school period the developmental ratings are advanced a year or more and such children reach puberty early and pass into adolescence with a minimal amount of physical and emotional difficulty.

Children who are below par physically from whatever cause not only mature more slowly but also tend to show erratic progress: one part of the skeleton may develop on the appointed time-schedule and another be retarded in development, thus making an accurate assessment of developmental age extremely difficult. Children having a prolonged adolescence are more likely to show permanent deviation, physical or mental, for they are exposed to environmental assaults for a long period of time.

Weight gain is extremely susceptible to fluctuations in health and metabolic balance. In a group of pre-school children we observed that certain children showed a considerable weight gain at one season of the year and a much poorer gain at another. Some children gained two, three and even four pounds in the winter whereas they might show an actual weight loss in the summer: others gained in the summer and not in winter. Checking over the health records it is apparent that this seasonal fluctuation is due to sensitivities effective only at certain times of the year. Children with hay-fever do well in winter and poorly in summer: children with allergies most active in winter do well in summer.

The problem of weight is, however, more complex than this. Certain children show tremendous gains in weight within a few months. This is apt to lead to a false belief that adipose tissue has been increased. It is possible by taking proper X-rays to obtain clear shadows not only of bone but also of muscle, subcutaneous tissue and skin. In certain individuals subcutaneous tissue shadows are clear and light and the skin shadow definite. The X-rays pass through such tissue easily. In other individuals the subcutaneous tissue shadow is opaque and the skin shadow poorly defined. X-rays do not penetrate this tissue as readily as the former. Subcutaneous tissues filled with fat cast a light shadow on the roentgenogram and the skin shadow is well defined. If these tissues are filled with a watery fluid the shadows are opaque and the skin poorly defined. The soft-tissue X-ray detects alterations in fluid metabolism long before there is any clinical manifestation of disturbance, the only other objective finding being rapid fluctuations in weight.

In using such delicate measures of metabolic efficiency it is of course necessary to be absolutely certain that the X-rays are comparable and that differences in density are not due to variations in technique. This can be

overcome by exposing a standard X-ray density gauge with each radiogram, and if the density gauges on two successive X-rays show identical shadows then an accurate evaluation of density changes in the bones can be made; any differences in muscle and subcutaneous tissue shadows are due to changes within the individual and not to any technical variation.

I have already pointed out that the epiphysial rating is an indicator of mineral balance. There are still more sensitive objective ratings of mineralization. If a person has good mineral reserves the interstices between the bone trabeculae of the cancellous bone are well filled with mineral. X-rays of such bone cast gray shadows and the trabeculae do not stand out distinctly. If the reserves are low the bone casts a lighter shadow, the trabeculae are easily seen and frequently there are small black islands among the trabeculae where the mineral is lost.

There are several factors which influence the mineral reserve. The intake itself may be low and when this is the case an addition of mineral to the diet will in a few months permit the individual to increase his reserves.

Rapid growth, such as occurs at adolescence, will frequently lower the reserves temporarily even though the intake is high. This is merely another expression of the strain of adolescence: after this period of rapid growth is completed reserves are quickly restored.

During the early months of pregnancy many women drain what mineral reserves they may have. During the later months their ability to utilize mineral improves (probably due to the increased hormone activity), and most of the women we have observed here build up quite well before delivery. After delivery there is a tendency to deplete these reserves whether or not lactation occurs. It is essential, therefore, that the diet be ample in mineral after delivery as well as before.

There are, however, many individuals whose reserves remain low at a time when there is obviously no unusual demand for mineral in spite of an abundant mineral ration. Mineral available in the diet is not utilized. Such individuals as usually found to be suffering from gastro-intestinal allergy. In these cases it is useless to pour in mineral without first finding the cause of the alimentary sensitivity.

In lowered vitality, muscle shadows likewise become less dense. This is correlated with other evidences of poor muscular tone such as poor posture, low foot arches, fatigue and general lassitude.

In arriving at an assessment of status of physical vigor it is necessary to carefully evaluate these various objective findings. It is quite possible to determine whether the individual is progressing or regressing. By a proper evaluation of the premonitory signs it is frequently possible to prevent an actual clinical manifestation.

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