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Orthopaedic Surgery in Infancy and Childhood

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Preface to the Third Edition

The author is grateful for the fact that this is a widely used text. It makes the difficulties inherent in a profusely illustrated text with wide coverage worthwhile.

The fact that children grow and that growth must constantly be taken into account both in recognition of the disease and in therapy is constantly emphasized. New material, from aids to laboratory diagnosis to the development of new surgical procedures, has been added.

Both Frank Stelling and William Donaldson have refreshed their respective sections on the upper extremity and scoliosis.

Mary Cosgrove has worked hard to keep the copy in readable condition for the printer.

The author is grateful for all this help and hopes the volume will continue to be useful and readable.

A. B. F., Jr.
Pittsburgh, Pa.

Preface to the First Edition

This volume is the outgrowth of that period in life when the subject matter of orthopaedic surgery was laboriously amassed by running from text to text and article to article. Excellent though so many volumes are, none of them appeared to have gathered under one cover details regarding the many odd syndromes encountered in the practice of orthopaedic surgery dealing with infants and children. Pediatricians and residents have often indicated by their questions that they were undergoing a similar experience.

No syndrome, photograph or roentgenogram is presented which was not personally seen by the author. No feature of disease is reiterated which has not been a feature in our own experience.

Obviously no text arises without roots in the past, and the excellent volumes of Colonna, Howorth, Mercer, Platt, Wiles, Fairbank, Shands, Campbell, Luck, Smillie and DePalma have also served as references. This text does not include a consideration of fractures, for the subject is adequately covered in Walter Blount's recent book, *Fractures in Children.*

If clarity in visualizing these syndromes has been achieved, it is a reflection of the teaching of Joseph Barr, William T. Green and Albert B. Ferguson, Sr. They are not responsible for what others may deem as errors, however.

Certain areas in the book have been done by others. Frank Stelling has contributed his knowledge of reconstruction of the hand to the section on the upper extremity. Scoliosis is the work of William Donaldson of Pittsburgh. John Donaldson of Pittsburgh has added the chapter on the neck. Robert Klein encompasses rickets and scurvy from the metabolic point of view. Albert Ferguson, Sr., writes of defective formation of bone from cartilage. All these authors are deserving of my humble thanks in enabling a sound production of a book on orthopedic surgery in the infant and childhood years.

The Children's Hospital of Pittsburgh is blessed with men of selfless spirit whose help has been invaluable. This is particularly true of Bertram Girdany, George Fetterman and Thomas Brower; although no one failed to respond when called upon. The pleasant and productive atmosphere of this hospital is a reflection of its guiding spirit and medical director, Edmund McCluskey.

The manuscript has been typed, retyped and retyped again by my secretary already overloaded with budgets, bills, and records. This type of dedication is typical of Mary Cosgrove.

My children and my wife, Louise, have taken night work, which deprived them of companionship, with good spirit. My wife's patient understanding is not found often in this world—without it such an arduous task could not be completed.

The drawings are the result of the talents of Margaret Croup except for those accompanying the section on the upper extremity. The photographs and roentgenogram reproductions were done by Albert Levine and James Stark. The patient cooperation exhibited by these worthy individuals has been a source of pleasure and has eased the task immeasurably.

The publishers and particularly Dick Hoover have been patient and have exhibited the skills of their profession with consummate ease.

Great care and effort have been used to duly credit thoughts, drawings and photographs whose origin might in any way be elsewhere. Should any omission have arisen, it is entirely inadvertent and not by conscious design.

The regional arrangement of the text will, we hope, make reference easy and invite a return visit.

A. B. F., Jr.

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Orthopaedic Treatment of Childhood Disability

The child is a growing, maturing individual, a fact that must be kept in mind in the treatment phases of orthopaedic disability.

Braces must be used to enlarge, not limit a child's horizon. All aspects of the child's development must be given attention at a time when the tendency is to rivet the attention on the single aspect of a deformity or loss of function under treatment. If treatment is always thought of in terms of total function of the child, these things can be brought into proper perspective. Surgical decisions are accurately made when the contribution of the surgical procedure to the total function of the child is ascertained. Decisions for long term hospitalization or physiotherapy must be made only after being weighed against the removal of the child from an area where emotional and intellectual development can be served. The rapid improvement in function occasionally possible with surgery is a point in its favor if it returns the child to a growth environment with greater opportunity to take part in it.

Many procedures fail because of a poor concept of what is necessary to make them work and increase the child's function. The procedure includes the post-operative period and the type of cast, traction, or physical therapy, the return home with adequate instruction for the parents and child, and the follow-up in the years following so that maximum function is achieved.

Factors which tend to make a deformity recur, such as growth, must be considered in on-going care. Unbalanced muscle pull and diseased tissue must be corrected or the limb braced till they can be corrected. The natural vigor of the child's tissues aids in regeneration of tissues if protection of the area is continued sufficiently long. During this period the hobbling effect of the treatment must be minimized so that the child can still take part in learning activities of all types.

GROWTH AFFECTING THE SKELETON

Many orthopaedic diseases may represent the development of a congenital abnormality. The variation usually appears in the specific age group in which

the particular portion of the skeleton normally is differentiated. Growth may affect the degree of development of an abnormality such as scoliosis. The effect of growth on the development of deformity in the presence of unbalanced musculature of the limb is a very important underlying consideration in orthopaedics. The growing child with one muscle group dominating another, as in poliomyelitis, must be braced; but the unbraced adult with the same clinical picture does not necessarily develop a deformity.

Some understanding of human skeletal growth and its effects is essential to an understanding of orthopaedic disease.

Skeletal Growth

In order to appreciate growth at a given age, two types of studies may be done. Cross sectional studies, to be significant, require a large number of children, but they are more co n only carried out than longitudinal studies because of the time involved in studying one child throughout its growth period. From cross sectional studies, the mean measurement of any particular skeletal attribute is obtained. From longitudinal studies, the rate of change can be determined. Longitudinal studies are quite readily available to the orthopaedist because he

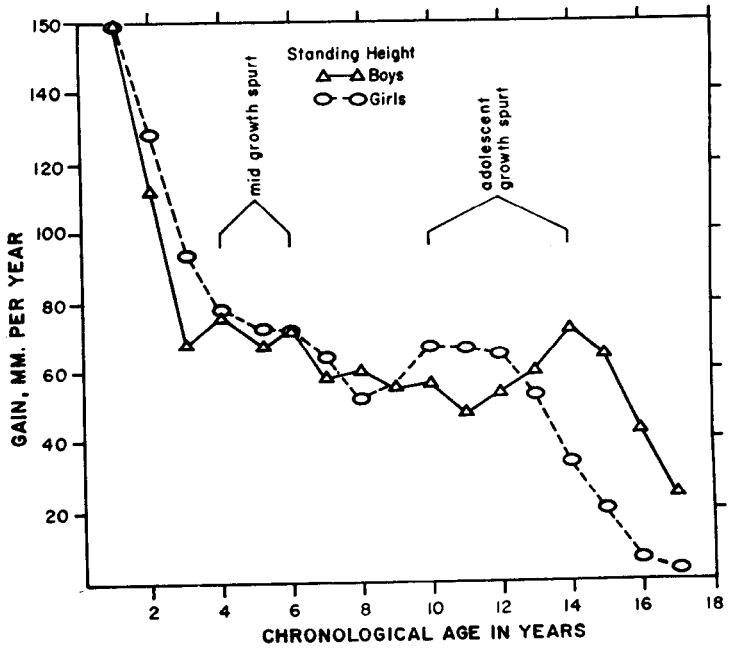

Figure 1: Note the declination in gain in height per year as growth progresses. The two periods during which this rate of decline levels off are known as the midgrowth spurt and the adolescent growth spurt. (*This chart and the following one are reprinted with the permission of J. B. Lippincott Co. from* DUTHIE, R.: The significance of growth in orthopaedic surgery, *Clin. Orthop.*, **14: 7**, 1959. *They were prepared from data that originally appeared in* SIMMONS, K.: The Brush Foundation Study of Child Growth and Development, II. Physical Growth and Development, Monograph, Society for Research in Child Development, Vol. 9, No. 1, Serial 37, 1944.)

usually follows up a patient throughout the growth period when a particular abnormality is present.

There is an exponential fall in the rate of mean gain in standing height for the human being except for two periods. The first delay in this fall is noted between five and a half and seven years and is called the midgrowth spurt. The second delay is the adolescent growth spurt between thirteen and fifteen years.

The growth rates in boys and girls are essentially the same except for the following variations. Boys may be slightly longer at birth, and they may grow slightly faster in the first year. Girls begin their adolescent growth spurt two years earlier than boys (at eleven instead of thirteen years). During this spurt, they grow faster and larger than boys, but, slowing quickly, they are finally smaller than boys in all dimensions except pelvic width. The boys, commencing their adolescent growth spurt two years later, go on to grow for a longer period and to larger dimensions.

Because their growth period is longer, the boys have longer legs. Hormonal influences give the boys wider shoulders and the girls a wider pelvis. In boys there is also a relative increase in the amount of growth of the trunk (sitting height) to that of the legs. The tremendous variation in this pattern in any one individual, racial group, or body type is readily evident.

Factors Affecting Growth

PRENATAL

The influence of inherited factors is accepted. Such orthopedic conditions as achondroplasia, spina bifida, dislocation of the hip, and osteogenesis imperfecta

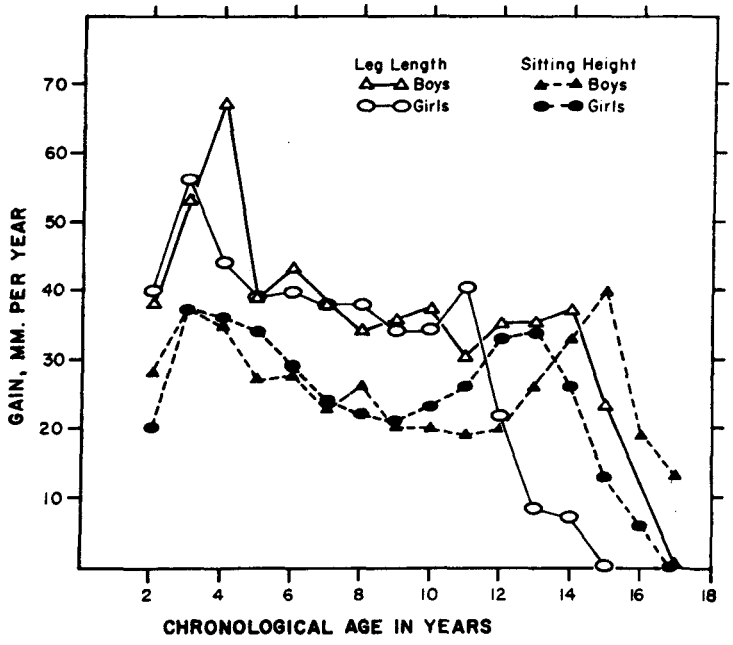

Figure 2: The gain in millimeters per year in sitting height and leg length is contrasted in boys and girls. The later increase in leg length and sitting height of boys is evident.

in genetic studies have been shown to result from a single gene mutation. The state of health of the mother also obviously affects the developing fetal skeleton.

POSTNATAL

Environmental and sociologic factors may influence the onset of puberty. Genetic factors are also still of importance. The state of health of the individual can result in skeletal dwarfism. Dietary factors are important.

Relation of Growth to Orthopaedic Conditions

The so-called osteochondritides are distinguished by their preference for a specific age group and often for a specific sex. If all cases of them were considered to occur at a physiologic rather than a chronologic age, their relationship to a specific age might be still more remarkable. Girls, because of their earlier skeletal maturation, would be expected to experience an earlier onset of these diseases, and, in osteochondritis involving the spine and Osgood-Schlatter disease, they do in fact.

Tumors such as osteogenic sarcoma, neuroblastoma, and Ewing's chondrosarcoma and giant cell sarcoma are distinguished by their occurrence in specific age groups.

Scoliosis is a noteworthy anomaly in terms of relating growth to skeletal disease. That the curve in idiopathic scoliosis ceases to progress when spine growth is complete is documented. Paralytic curves that have been doing well often develop into severe deformity during the adolescent growth spurt.

Temporary deformities that normally occur during development, such as genu valgus, which appears between the ages of two and four years and gradually improves thereafter, internal tibial torsion, and anteversion of the hip, are evidence of the influence of growth on the skeleton. The examples are many, for

Osteochondritis of:	Usual Age at Diagnosis	Range of Age Incidence	Sex Incidence	Year of Appearance of Epiphysis MALE	FEMALE
Upper Femoral Epiphysis (Legg-Calve-Perthes' Disease)	5 - 9	3½ - 15	M > F	1	½
Tuberosity of Tibia (Osgood-Schlatter's Disease)	12 - 15	10 - 23	M > F	11	11
Navicular Bone (Kohler's Disease)	3 - 8	2½ - 10	M > F	2 - 4	2 - 4
Calcanean Tubercles (Haglund's Disease)	8½ - 15	8 - 22	M > F	10	8
Head of Second Metatarsal Bone (Freiberg's Disease)	10 - 18	10 - 45	F > M	3	2
Upper and Lower Epiphyses of Vertebrae (Scheuermann's Disease)	10 - 21	•	M > F	10	10

Figure 3: The relationship of some orthopedic conditions in childhood to specific age groups. Growth and its effects may be a prime underlying factor in delineating these age groups. (*Reproduced with the permission of J. B. Lippincott Co. from* DUTHIE, R.: The significance of growth in orthopaedic surgery, *Clin. Orthop.*, 14: 7, 1959.)

the influence of growth can be seen in most skeletal changes—normal and abnormal—of childhood.

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MOTOR DEVELOPMENT

Some standard pattern of motor development must be borne in mind by the physician examining children. It is well to remember, for instance, that to prefer to use one upper extremity rather than the other before the age of one year is abnormal. Before the age of eighteen months, such a preference raises the suspicion of the examiner and suggests the possibility of underlying neural damage, such as might exist with hemiplegia in cerebral palsy.

A normal sequence of motor events is roughly as follows. In the first two weeks, the infant exhibits mass activity of the limbs, and the eyes focus on light and on the face of the observer. Crying occurs with discomfort. At one month, the chin and chest are up and the eyes follow a moving object. At three or four months, the infant laughs and brings the hand to the mouth. The feet push and the reach for a rattle occurs. In the six- to eight-month range, the infant learns to sit alone, to transfer a toy from one hand to the other, and to pull the hair of an observer. By eight or nine months, the youngster stands with support. By eleven or twelve months, he can pull himself up to stand; and at twelve or fourteen months he can walk, repeat words, recognize sounds, and name a few objects. Running starts at sixteen to eighteen months. By twenty-four months, the child climbs on furniture and jumps off, obeys simple commands, and investigates objects of interest. He opens cupboards and drawers and begins to use simple sentences.

All such indications of timing are rough approximations and guides, not absolute rules.

Secondary Effects of Immobilization

Immobilization removes a child from an opportunity for learning experience. In addition, immobilization results in an adjustment of the muscles of the limb or trunk to a new fixed position.

This adjustment is termed "myostatic" contracture. It may be defined as the adaptation of an innervated muscle to a new functional length. Such a process cannot occur in a flail muscle without tone. It cannot occur in joint capsule or synovia which is in a normal state, except over a very prolonged period of time when the collagen fibers could become reoriented to new stresses. The principal cause for joint stiffness when a plaster cast is removed is the development of a myostatic contracture in the muscles.

There are no joint adhesions in the normal joint although they may exist in

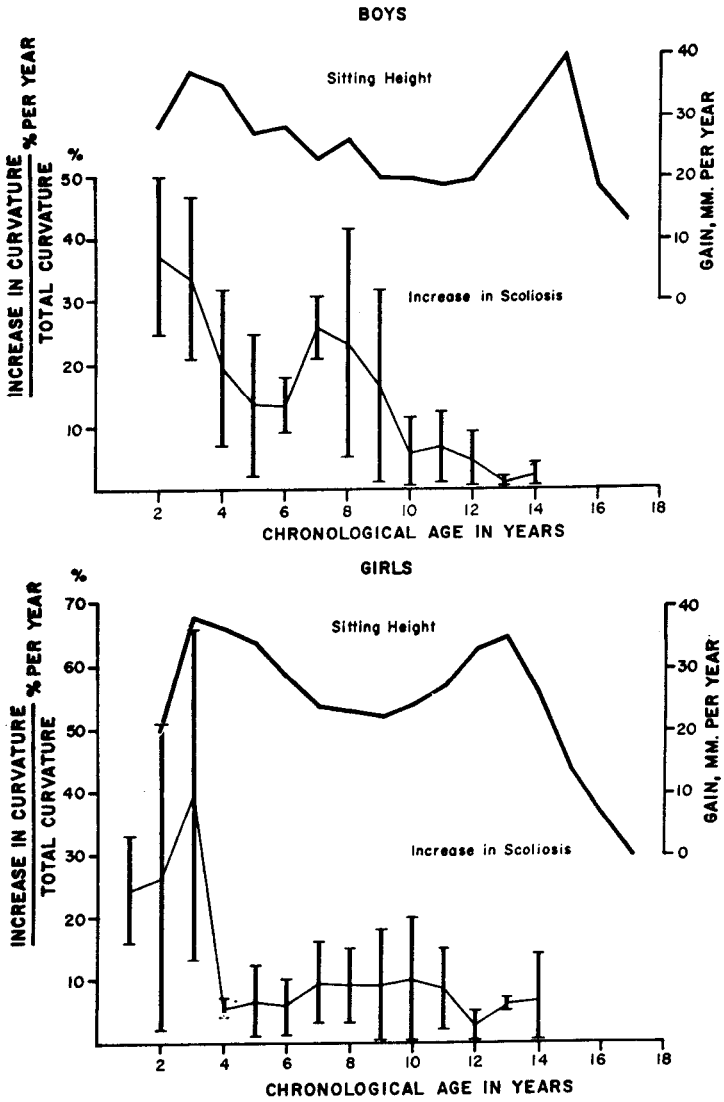

Figure 4 (*A* and *B*): The relation of increase in curvature in children with infantile scoliosis to the gain in millimeters per year in sitting height.

the inflamed or diseased joint. Trauma and the development of edema inflammation and fibrin deposits in tendon sheaths, torn muscle bellies, and around joint capsules may aid this process.

The treatment of myostatic contracture is active exercise controlled by the patient. Passive stretching may tear tissues and compound the process. The treatment of limited motion at the elbow resulting in flexion contracture, for instance, is active flexion and extension of the elbow—not carrying a pail of water. This latter type of passive stretching results in a painful, still further limited elbow with muscle spasm.