Disorders of Growth and Puberty

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Financial Disclosure

- I have no financial relationships with commercial interests to disclose
- I will not discuss any brand name or unauthorized use of any medications

Introduction

- Growth begins at conception
- Influenced by multiple factors throughout life
- Wide range of normal variability
- Not all short children have abnormal growth
- 2 million children are shorter than 98% of their peers
- Most are normal and healthy

Objectives

- Review normal and abnormal patterns of growth
- Recognition and evaluation of growth problems
- Discuss psychological and emotional aspects of short stature

Prenatal Growth

- Strongly influenced by maternal health
- Positively by good health and nutrition
- Negatively influenced by smoking, alcohol, autoimmune disorders, infections, diabetes, multiple gestation and genetic factors
- Primary growth factor is INSULIN

Infancy

- Not unusual for infants < 2 to cross centiles
- Small babies tend to cross centiles upward - “catching up” to their growth potential
- Large babies of short parents tend to cross centiles downward to achieve their genetic potential
- Process completed by 24 months
Childhood
- Crossing centiles after age 2 is unusual
- Once child reaches centiles of genetic potential by age 2, growth should settle parallel to the 50 percentile line
- Crossing centiles should prompt investigation

Genetic Potential - Mid Parental Height (MPH)
- Males in a family are generally 5 inches taller than females
- MALES: \[ \frac{\text{father's height} + (\text{mother's height} + 5\text{"})}{2} \]
- FEMALES: \[ \frac{\text{father's height} - 5\text{"} + \text{mother's height}}{2} \]
- Should track +/- 4" from MPH

Puberty
- Will see growth begin to shift upward
- Girls onset after age 8
- Boys onset after age 9
- Duration is 2 to 4 years
- Girls grow early in puberty - peak T3
- Males grow later in puberty - peak T4

Growth Charts
- Accurate measurements, well plotted are the single most valuable tool for assessing growth
- Most common errors are not plotting, plotting at wrong age, wrong sex charts, using recumbent chart for standing children, shoes and hair clips and failing to recheck outlying points on the curve

Infants’ Growth Charts
- Recumbent charts birth to 36 months
- Fraught with errors: poor measurements with struggling child, poor technique (not well positioned), poor equipment (pencil marks on exam table paper), plotting at wrong age
- Children over 2 years often measured standing
Children's Growth Charts
- Standing, from ages 2 to 20 years
- Common errors: plotting at wrong chronological age, child not standing straight, shoes and hair clips on
- Often need to go back through chart to "reconstitute" the growth chart
- May need to follow prospectively for 6 months to assess growth

Growth Velocity
- Measured in centimeters/year
- Varies dramatically by age
- At birth: baby is 50 cm long
- Grows 25 cm first year
- Grows 12.5 cm second year
- Grows 5-6 cm/yr until puberty
- Puberty: 8-12 cm/yr
Screening Labs

- CBC, ESR
- Chem Panel, LFT
- U/A (USG)
- TFT, IGF-1, IGF-BP3
- IgA, Antigliadin Ab, TTG (IgG & IgA)
- Bone Age

Possible Causes of Short Stature Without Growth Failure

- Familial Short Stature
- Constitutional Growth Delay
- Idiopathic Short Stature
- Comprise 90% of short children

Familial Short Stature

- Short parents tend to have short children
- Small for their age
- Come from short families
- GROWING AT A NORMAL RATE
- No signs or symptoms of illnesses that affect growth
- Bone Age = Chronological Age
- Growth expected for MPH
Constitutional Growth Delay
- Small for age; males > females
- Normal size at birth
- Fall to at/below 5% by 2 years
- Then grow at normal rate
- Bone Age < Chronological Age
- Late entering puberty
- Positive family history
- No signs or symptoms of illness

Idiopathic Short Stature
- Small for age
- Small normal to IUGR at birth
- Normal rate of growth after infancy
- Normal size parents
- Bone Age = Chronological Age
- Enter puberty at normal time
- No signs or symptoms of illness

Short Stature With Growth Failure
- Systemic Diseases
- Endocrine Diseases
- Congenital Conditions

Systemic Diseases
- Impair growth by affecting overall health and nutrition
- Nutritional Deficiency accounts for most cases of growth failure worldwide
- Rare in the U.S.
- Failure to feed - common with neglect
- Diseases of the digestive tract
Nutritional or GI Disorders
- Poor weight gain
- Low weight for height
- Nausea, vomiting, diarrhea or constipation
- Abnormal bowel movements
- Bloating, abdominal distention
- Growth resumes when treated correctly

Kidneys, Liver, Heart and Lungs
- RTA - poor growth in all 3 parameters
- Cyanotic heart disease
- High output failure - AVM’s
- Cystic Fibrosis
- Biliary atresia

Psychosocial Dwarfism
- May not be obvious from history
- Often accompanied by ravenous appetite
- Fall off weight > height > OFC
- Low IGF-1
- May test as growth hormone deficient

Endocrine Diseases
- Hypothyroidism
- Hypercortisolism
- Growth Hormone Deficiency
Hypothyroidism
- Congenital or acquired
- Growth failure may be only sign
- Poor energy and concentration
- Constipation
- Dry skin
- Hoarseness
- Cold intolerance
- Coarsening of facial features

Acquired Hypothyroidism

Hypercortisolism
- Most commonly exogenous
- Centripetal weight gain, growth arrest
- Thin skin, striae
- Easy bruising
- Osteopenia
- Muscle wasting and weakness

Polyarteritis Nodosum

Growth Hormone Deficiency
- Presents as marked slowing of growth
- Usually continue to gain weight
- Cherubic facies; Normal proportioned
- Normal intelligence
- May have hypoglycemia
- Congenital or acquired (craniopharyngioma, XRT)
- BA < HA < CA

IUGR
- Plot small for dates on growth chart
- May be explained by maternal factors
- May be explained by placental factors
- May be intrinsic to the fetus
- 90% catch up by 2 to 3 years of age or not at all
Congenital Growth Hormone Deficiency

Acquired Growth Hormone Deficiency

Congenital Conditions
- IUGR
- Genetic Syndromes
- Skeletal Dysplasias

Genetic Syndromes
- Turner Syndrome
  - “All short girls have Turner Syndrome until proven otherwise”
- Down Syndrome
- Russell Silver
- Prader Willi (H4O)
Prader Willi Syndrome

Skeletal Dysplasias
- Present at birth, more than 100 types
  - Achondroplasia
  - Hypochondroplasia
  - Multiple epiphyseal dysplasias
  - Disproportionate short stature

Psychological/Emotional
- Society places positive emphasis on height
- Parents place positive emphasis on height
- Teachers place positive emphasis on height
- Employers place positive emphasis on height

Psychological/Emotional
- Boys identified at younger ages
- Girls often greatly delayed
- Child treated according to size rather than age
- Blame often/always misplaced
- Expectations often do not equal reality

Psychological/Emotional
- Tend to be targets of bullies
- May miss out on athletics
- Helpful to chose sports requiring intelligence more than size
- Need to identify challenges early and help families acquire coping skills
- Identify strengths

Summary
- 2-1/2% of all children are short
- Majority are normal
- Adequate history, physical exam, well accomplished growth chart and limited lab/rad studies can diagnose most children
- FOLLOW-UP MUST BE EMPHASIZED; REEVALUATE IF NOT MEETING EXPECTATIONS