Short Stature Evaluation in Children

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October 1, 2016
Disclosure Information

2nd annual Pediatric Symposium
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I have the following financial relationships to disclose:

--Speaker’s Bureau for: Novo Nordisk, AbbVie

I will not discuss off label use and/or investigational use in my presentation.
Learning Objectives

- Be able to identify which children to evaluate for a growth disorder
- Understand the diagnostic evaluation of short stature
- Be familiar with the indications for growth hormone treatment in children
Normal growth

3 Stages of Postnatal growth

- **Infancy**
  - Rapid growth: ages 0-2 years

- **Childhood**
  - Steady growth
  - Prepubertal slowing

- **Adolescence**
  - Pubertal growth spurt
Phases of Childhood Growth

Karlberg J. Acta Paediatr Scan, suppl 356:26;1989
Confounding Factors in Early Childhood Growth

- Genetic channeling
  - Upward or downward movement toward mid-parental height range
  - Usually accomplished by 12-15 months

- Constitutional growth delay
  - Family history
  - Slow growth rate between 12-30 months

- Poor weight gain impairing growth

- Length vs height measurements
Confounding factors in Late Childhood Growth

- Less frequent measurement opportunities
- Normal prepubertal growth deceleration
- Effects of medications for common disorders (ADHD, asthma)
- Normal variation in the onset of puberty
Who should be evaluated

- How short is the child?
- Is the child’s height velocity impaired?
- Is the child’s growth within the expected range for the family?
Is the child short?

- Accurate measurement is essential
  - Length: 0-2 years
  - Height: 2-18 years

- Accurate plotting
  - WHO chart: 0-2 years
  - CDC chart: 2-18 years

- Short stature is defined as a height more than 2 SDs below the mean
  - $< 2.3^{\text{rd}}$ percentile
Is the child’s height velocity impaired?

- Growth velocity is important
- Requires serial measurements over time
  - At least 6 months apart
- Normal range of growth velocities depends on age and stage of puberty
- Height velocity is impaired if:
  - Height crosses 2 major percentile curves
  - Height velocity abnormal for age
Growth velocity curve
Is the child’s growth within the expected range for the family?

- **Midparental height**

  Midparental height for **girls**: 
  
  \[
  \text{Midparental height} = (\text{Fathers ht - 5 in}) + (\text{Mothers ht})
  \]

  Midparental height for **boys**: 
  
  \[
  \text{Midparental height} = (\text{Mothers ht + 5 in}) + (\text{Fathers ht})
  \]

  Target Height = Midparental Height +/- 2 SD

  1 SD = 5 cm (≈2in) 2 SDs = 10 cm (≈4 in)

- **Projected height**
Bone age

- X-ray of left hand and wrist
- Evaluates growth potential
- Can be used to predict adult height
- If referring, please send a copy of the bone age film!
Who should be evaluated?

- Short stature
- Abnormal growth velocity
- Height not consistent with genetic potential
Growth evaluation: History

- Birth length and weight
- Midparental height
- Family growth and pubertal history
- Medications
- Timing of pubertal development
- Health history
Growth evaluation

- Bone age
- CBC, comprehensive metabolic panel, sedimentation rate
- Thyroid function tests
- Celiac screen (TTG, IgA)
- IGF-1, IGFBP-3
- Karyotype for girls
- Growth hormone stimulation testing
Most cases of short stature are...

- Constitutional delay of growth
- Genetic short stature

Which patients are candidates for growth hormone?
FDA Approved Indications for Growth Hormone therapy in Children

- Growth hormone deficiency [1985]
- Chronic renal insufficiency [1993]
- Turner syndrome [1997]
- Prader Willi syndrome [2000]
- SGA without catch-up growth by 2 years [2001]
- Idiopathic short stature [2003]
- SHOX deficiency [2006]
- Noonan syndrome [2007]
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Growth hormone deficiency

- 1:4000-1:10,000 children have GHD
- Hallmark sign is growth failure
- Congenital
  - Slightly low to normal birth length
  - Hypoglycemia, jaundice, microphallus
  - Postnatal growth failure
  - Several genetic mutations identified
  - Other pituitary hormone deficiencies
- Acquired
  - Growth failure
  - Delayed bone age
  - Increased central body fat
GH stimulation testing

- Measurement of GH secretory reserve
- Uses pharmacologic stimuli
  - Arginine
  - L-DOPA
  - Clonidine
  - Insulin
  - Glucagon
- Measure GH every 15-30 min for 3 hrs
Diagnosis of GHD

- Growth hormone stimulation testing has limitations
  - Not physiologic
  - Poor reproducibility
  - Arbitrary “normal” range

- The diagnosis of acquired GH deficiency is based on multiple factors
  - Growth rate
  - Bone age
  - Midparental height
  - IGF-1, IGFBP-3
  - Results of GH stimulation testing
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Turner Syndrome

- **Suspect in every poorly growing girl**
- **1:2500 Live births**
- Diagnosed by karyotype: Deletion or change in one of the X chromosomes
- **100% of patients have poor growth with a variety of other findings**
- Pathology is not GH deficiency but a relative GH resistance
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Definition of SGA

- SGA is defined as: birth length and/or weight at least 2 SD’s below the mean for gestational age. It represents a statistical grouping of infants. SDs=standard deviations.
SGA/IUGR children:

- The majority of catch-up growth is usually achieved by 2 months of age.
- 86% achieve length catch-up growth during the first 6-12 months of life.
- 92% achieve length catch-up growth by 2 years of age.
- If a child born SGA has not caught up by 2 years, catch-up growth is unlikely!
Usher and McLean Growth Curves: Classifying Infants as SGA

Birth Weight (g) vs. Gestational Age (wk)

-2 SD’s (5-11 & 18 ¾”)

Crown-Heel Length (cm) vs. Gestational Age (wk)

SGA

Growth hormone in SGA Children

- Abnormal patterns of GH secretion have been observed.
- Most children with short stature born SGA are not GH deficient.
- GH therapy is safe and effective in short children born SGA
- Should be considered in short children born SGA without catch up growth at 2 years of age
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Idiopathic Short Stature (ISS)

- Height -2.25 SDs below the mean for age or < 1.2 percentile
- Anticipated final height of under 4’-11” for females and under 5’-3” for males
- No other identifiable etiology of short stature
GH in Idiopathic Short Stature

- Approved by the FDA in 2003
- Expected growth hormone sufficiency
- Estimated benefit of 4-7 cm (1.5-2.8 inches) of gain in height
- Estimated $50,000 per inch
- Typically not covered by insurance
- Remains controversial...
Summary

- Evaluate children with short stature and/or growth failure
- Need to rule out medical causes of short stature
- Most children with short stature have constitutional delay or genetic short stature
- Growth hormone treatment follows FDA indications
Thank you!

Call anytime with questions
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