Growth disorders in children

Growth disorders in children can be classified as growth retardation (manifesting as short stature) or excessive growth. Knowledge of growth physiology and diagnosis of its abnormalities is a key component for fault detection.

Physiology of child growth

🔎 *For more information see Child growth and development.*

The human **growth model** is likened to a **sandwich**, because there is a period of steady growth (childhood; years 2 to 11) between the rapid postnatal and pubertal growth periods. This model is different from other biological species and is described as the **ICP growth model** by the Swedish auxologist Karlberg:

- **I (infancy)**: it extends from the 2nd half of the intrauterine developmental period to the 3rd-4th year of life. **IGF-I** plays an important role in this phase.
- **C (childhood)**: it begins before the end of the 1st year of life and lasts until the end of physical growth. The dominant hormone is **growth hormone** with IGF-I persisting.
- **P (puberty)**: this is the puberty-induced additional growth phase. It accelerates growth to the age of highest growth rate and then slows down until the end of growth. The major influencing factors are **sex hormones**.[1]

Diagnostics

The basis of diagnostics is an accurately measured body height using a stadiometer and a reconstruction of the anamnestic **growth curve** from previous data, allowing for retrospective assessment of growth rate. One compares the current height with the parent **height prediction** and assesses the stage of puberty (the future adult height of the child is estimated by projecting the current position of the child in the percentile graph on the right margin at the age of 18).

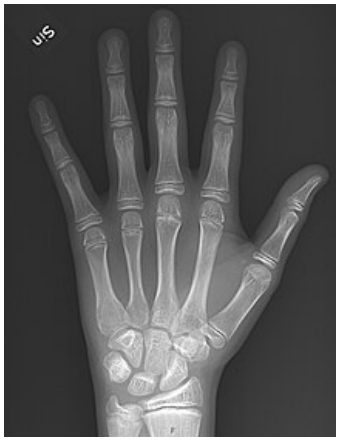
Parental prediction (cm):

- For boys: (father's height + mother's height + 13)/2
- For girls: (father 's height + mother' s height - 13)/2

This reveals a possible "benign" familial growth retardation.

It is best to use a tiered diagnostic algorithm. The next step is routine laboratory tests (blood count, inflammatory parameters) supplemented by an X-ray of the hand to assess bone age. Subsequently, the following should be looked for:

- High sedimentation may indicate Crohn's disease.
- Increased creatinine reveals chronic renal failure.
- A disorder of calcium-phosphate metabolism indicates the possibility of vitamin D-resistant rickets or pseudohypoparathyroidism.
- Metabolic acidosis raises suspicion of renal tubular acidosis.
- Anti-endomysial Ig is a sign of celiac disease.
- TSH, fT4



Today, automatic calculations can be used to examine bone age

Growth hormone secretion testing is usually indicated if IGF-1, which correlates with mean growth hormone levels, is decreased. It is performed by a **stimulation test** in which substances such as clonidine or pyridostigmine are administered and hormone secretion is observed. The insulin hypoglycemia stimulation test is reliable but risky. The final diagnostic test to be performed in children with growth hormone deficiency is MRI.[2]

Genetic testing

In the case of short stature with an unknown etiology, it is recommended for the patient to undergo a genetic examination. Especially in girls, it is necessary to rule out Turner syndrome (the only manifestation of which may be a small stature in the prepubertal period). **Karyotype examination** can also be indicated in boys (to exclude the rare condition 45, X / 46, XY mosaicism). In both sexes, a ***SHOX* gene examination** is then indicated to rule out idiopathic short stature associated with SHOX deficiency.

Growth retardation

Growth retardation is defined as a **child's height below the 3rd percentile for a given age** or **growth rate below the 25th percentile for a given age** (calculated from two measurements at least 6 months apart.)

Etiology

There are 4 main groups of affected children:

Small children who are healthy ("short-normal")

They make up the largest part, about 80% - their height is low, but the growth rate is usually normal. There are two major reasons for this:

- Familial small stature (FSS)
- Constitutional growth retardation and puberty (CDGA)

A common feature is the absence of a demonstrable medical condition associated with growth retardation. This group's heigh is considered to be a variant of normal.

Children with endocrine disorders

This is a fraction of children with growth retardation (1-2%). Early diagnosis is important because normal height can be achieved with early treatment. Their general condition is seriously affected, but the disorders are usually well treatable. Disorders include growth hormone deficiency, hypothyroidism, or previously undiagnosed diabetes mellitus.

Children with chronic systemic diseases

Most chronic conditions lead to growth retardation. The spectrum of diseases is wide with most of them affecting the hormonal axis (IGF-I), calcium phosphate metabolism, or bone growth directly. Growth adjustment is usually dependent on the successful treatment of the basic cause. Disturbances (decreases) in IGF-1 production in the liver can occur due to protein-energy malnutrition, hypoxia, acidosis, etc... Its production is also affected by growth hormone (whose secretion can be reduced in psychosocial hardship). The effect of growth hormone treatment has been demonstrated in some diagnoses (especially in chronic renal insufficiency).

Children with primary skeletal growth disorders

In these children completely normal levels of hormones, including IGF, are typical. Growth is mostly disproportionate. The classical example of this is achondroplasia (or a milder variant of hypochondroplasia): growth disruption is due to a mutation in FGFR3. There are other bone dysplasias and chromosomal abnormalities such as Turner syndrome can lead to growth retardation.

Disproportionate growth in achondroplasia

Growth retardation therapy

In children with growth hormone deficiency, hormone replacement therapy is necessary with subcutaneous injections every night. Successful treatment has been demonstrated in people with Turner syndrome and chronic renal failure. Puberty also needs to be regulated in Turner syndrome.

Excessive growth

Body height above the 97th percentile for a given age, or growth rate above the 75th percentile for a given age, are less likely to be examined by a physician than insufficient growth, as the physiological variant of a taller figure is perceived as socially beneficial. Growth disorders associated with overgrowth are significantly less common.

Etiology and diagnostics

- **Physiological variants**: familial tall stature, constitutional growth acceleration, and puberty.
- **True premature puberty**
- **Premature pseudopuberty**: adrenal tumor, gonadal tumor, congenital adrenal hyperplasia, testotoxicosis, McCune-Albright syndrome, ectopic production of gonadotropins (e.g., hepatoblastoma).
- **Endocrinopathy**: thyrotoxicosis, gigantism.
- **If present with dysmorphic symptoms**:
  - Marfan's syndrome - long slender limbs, arachnodactyly, scoliosis, aortic dissection...
  - Homocystinuria - marfanoid body habitus, mental retardation...
  - Cerebral gigantism - macrosomia at birth, prominent body, large arms and legs...
  - Klinefelter's syndrome - disproportionately long limbs (eunuchoid growth)...

Therapy

Sometimes parents of girls with a physiological "tall-normal" body variant come with a request for height reduction. Theoretically, this can be done with estrogen; however, this will induce puberty in prepubescent girls and there is a risk of tumor development. Similarly, testosterone can theoretically reduce achievable adult height.

Links

Related Articles

- Failure to thrive
- The growth and development of the child

Source

- BENEŠ, Jiří. *Studijní materiály* [online]. ©2007. [cit. 2009]. <http://www.jirben.wz.cz/>.

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2. ↑ KYTNAROVÁ, . *Endokrinologie 2* [přednáška k předmětu Předstátnicová stáž z pediatrie, obor Pediatrie, 1. LF Univerzita Karlova]. Praha. 29. 10. 2019