NORMAL AND ABNORMAL PUBERTY

NORMAL PUBERTY

Definition:

- Puberty encompasses the psychological, physical, and endocrinologic changes beginning in late childhood that ultimately allow for reproductive capacity.

- The average age of onset of puberty in girls is 9 years. Once initiated, it proceeds over an average of 4 to 5 years and culminates in the onset of menses.

- Increased production of LH and FSH, as well as other factors (such as leptin), is responsible for the initiation of the pubertal process.

Physical Changes Associated with Puberty:

1. Growth Spurt:
   - begins before the onset of other signs of puberty and reaches peak growth velocity at an average age of 11 to 12 years (usually 1 year before menarche).

2. Thelarche:
   - The onset of breast development.
   - Usually, begins between 9 to 10 years of age and is completed approximately over 3 years.
   - It is a sign of ovarian estrogen production.

3. Adrenarche and pubarche:
   - Adrenarche: the production of androgens from the adrenal gland.
   - Pubarche: the development of axillary and pubic hair as a result of adrenal and gonadal androgens.
   - They usually occur at age of 10-11 years.
   - Adrenarche is not regulated by the same hypothalamic-pituitary process that governs the rest of puberty.

4. Menarche:
   - The onset of menses.
   - It occurs due to hormonal changes specifically, estrogen production by the ovary.
   - The average age of the first menses is 12 to 13 years.
   - For the first 2 years following menarche, menses are often irregular because of anovulation or sporadic ovulation.
### Tanner Stages of Breast and Pubic Hair Development:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Breast Development</th>
<th>Pubic Hair Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Elevation of Areola only.</td>
<td>No pubic hair.</td>
</tr>
<tr>
<td>II</td>
<td>Elevation of the breast as a small mound; enlarged areola diameter.</td>
<td>Sparse, long pigmented terminal hair chiefly along libia majora.</td>
</tr>
<tr>
<td>III</td>
<td>Further enlargement without separation of breast and areola.</td>
<td>Dark, coarse, curled hair sparsely spread over mons pubis.</td>
</tr>
<tr>
<td>IV</td>
<td>Secondary mound of areola and papilla above the breast; areola pale and immature.</td>
<td>Adult-type hair, abundant but limited to mons pubis.</td>
</tr>
<tr>
<td>V</td>
<td>Recession of areola to contour of breast; darkening of areola and development of glands and ducts.</td>
<td>Adult-type coverage in quantity and distribution with spreading to inner aspect of the thigh.</td>
</tr>
</tbody>
</table>

#### Secondary Sexual Characteristics:

- They are features that distinguish the two sexes of a species.
- They are not part of reproductive system as primary sexual characteristics which refer to development of reproductive organs.
In humans, secondary sex characteristics include:

- **Female:**
  - Enlargement of breasts and erection of nipples.
  - Growth of body hair, most prominently underarm and pubic hair.
  - Greater development of thigh muscles behind the femur, rather than in front of it.
  - Widening of hips, lower waist to hip ratio than adult males, on average.
  - Smaller hands and feet than men.
  - Rounder face.
  - Smaller waist than men.
  - Upper arms approximately 2 cm longer, on average, for a given height.
  - Changed distribution in weight and fat; more subcutaneous fat and fat deposits mainly around the buttocks, thighs and hips.
  - Changes in voice.

- **Male:**
  - Growth of body hair, including underarm, abdominal, chest, and pubic hair. Loss of scalp hair *androgenic alopecia* can also occur.
  - Greater mass of thigh muscles in front of the femur, rather than behind it as is typical in mature females.
  - Growth of facial hair.
  - Enlargement of larynx (Adam’s apple) and deepening of voice.
  - Increased stature; adult males are taller than adult females, on average.
  - Heavier skull and bone structure.
  - Increased muscle mass and strength.
  - Larger hands and feet than women, prepubescent boys and girls.
  - Square face.
  - Small waist, but wider than females.
  - Broadening of shoulders and chest; shoulders wider than hips.
  - Increased secretions of oil and sweat glands, often causing acne and body odor.
  - Coarsening or rigidity of skin texture, due to less subcutaneous fat.
  - Higher waist-to-hip ratio than prepubescent or adult females or prepubescent males, on average.
  - Enlargement growth of the penis.
ABNORMAL PUBERTY

--- PRECOCIOUS PUBERTY ---

**Definition:**
- This condition is characterized by the onset of puberty before 8 years of age. (8 years in girls, 9 years in boys)
- Incidence: 5 times higher in girls than boys.
- More common in female, but more suggestive of pathology in male.

**Causes:**
- There are two types of precocious puberty:
  
- **Central (True) Precocious Puberty:**
  - Due to premature activation of the hypothalamic-pituitary-ovarian axis.
  - \(\Rightarrow \) gonadotropin stimulation of ovarian follicles to produce estrogen. *(Hypergonadotrophic Hypergonadism)*
  - Causes:
    - Idiopathic (Constitutional):
      - the most common type.
      - Unexplained premature activation of H-P-O axis.
      - Mostly, affects girls > 5 years.
    - CNS lesions:
      - Secondary to CNS lesions e.g., tumor, hamartoma (e.g., Neurofibromatosis), \(\uparrow\)ICP, infections, post-meningitis, obstruction, radiotherapy, etc. ....
      - Mostly, affects girls < 5 years.
    - In addition, primary severe hypothyroidism may also present with premature activation of H-P-O axis for unknown causes.

- **Peripheral (Pseudo-) Precocious Puberty:**
  - is mediated by ovarian production of estrogen independently on gonadotropin stimulation. *(Hypogonadotropic Hypergonadism)*
  - Causes:
    - ovarian tumor producing estrogen e.g., **granulose cell tumor** and fibrothecoma.
    - Exogenous estrogen administration.
McCune-Albright Syndrome (Polycystic Fibrous Dysplasia):
  - An endocrine dysfunction resulting in triad of:
    \[ \Rightarrow \text{precocious puberty} + \text{cafe-au-lait spots} + \text{fibrous dysplasia of skeletal system} \]

**Diagnosis:**

- History:
  - Symptoms of puberty, family history of puberty onset, medical illnesses, ...

- Physical Examinations:
  - Growth velocity, Tanner staging, neurologic examinations, ...

- Investigations:
  - Hormonal assay: LH, FSH, GnRH test, estradiol, TSH.
  - Bone age: often advanced age.
  - CT or MRI of head.
  - US for adrenal, pelvis.

**Management:**

- **GnRH agonists (Lupron):**
  - Useful with idiopathic cases.
  - Binds to hypothalamic receptors \( \Rightarrow \) suppresses gonadotropin release.
    \[-(ve \text{ feedback})--\]
  - When these agents are discontinued at an appropriate chronological or physiological age, normal hormonal cycling resumes.

- **Medical or surgical therapy for CNS lesions.**

- **Aromatase inhibitors (e.g., fadrozole):**
  - are used with McCune-Albright syndrome.
  - They block peripheral conversion of testosterone to estradiol.

- **Surgical excision of estrogen producing tumor.**

- **Medroxyprogesterone:** to slow breast and genital development.

**Prognosis:**

- Sexual functioning and fertility remain intact.
- Short stature results from premature estrogen-mediated closure of epiphysis of long bones.
---DELAYED PUBERTY---

**Definition:**
- Absence of pubertal development by age of 13 in girls. (14 in boys).
- More common in male, but more suggestive of pathology in female.

**Causes:**
- Similarly, there are two types:
  - **Central Causes:**
    - Due to delayed activation of H-P-O axis.
      \[\Rightarrow\text{(Hypogonadotropic Hypogonadism)}\]
    - Mostly, idiopathic (constitutional) --- Most common.
  - **Peripheral Causes:**
    - Due to primary gonadal failure.
      \[\Rightarrow\text{(Hypergonadotropic Hypogonadism)}\]
    - Causes:
      - Genetic causes: e.g., Turner's syndrome, Kleinfelter syndrome.
      - Gonadal damage: trauma, infection, radiation.
      - Gonadal dysgenesis.
      - Hormonal defects: e.g., adndrogen insensitivity, 5α-reductase deficiency.

**Diagnosis:**
- **History:**
  - weight loss, short stature, family history of puberty onset, medical illness,
- **Physical Examinations:**
  - growth velocity (minimum 4 cm/year), Tanner staging, neurological exam, complete physical exam,
- **Investigations:**
  - Hormone levels: LH, FSH, GnRH, TSH, estradiol,...
  - Bone age.
  - CT & MRI of head.
  - Karyotype: to rule out Turner syndrome specially for those who are $<3^{rd}$ percentile in height.
Management:
- Identify and treat the underlying cause.
- Hormonal replacement cyclic estradiol and progesterone.

--GOOD LUCK--

Ibrahim Tawhari