PUBERTY

Yaqeen almasri
Rama salim
Ahmad abu khadra

DEFINITION

- is the normal process of physical, endocrinology and psychological changes through which child's body matures into an adult body of sexual reproduction
- Puberty is a period of time (8-13) years old in females
- Characterized by maturation of hypothalamic- pituitary-gonadal axis

  - appearance of 2ry sex features
  - acceleration of growth
  - capacity for fertilization

CAUSES OF PUBERTAL CHANGES

1) General health (nutritional status, body weight, activity)
2) Genetics
3) Psychological factors
4) Melatonin release

PHYSIOLOGY

Time	Event	
Fetal onset	- By 20 weeks' gestation → dramatic ↑ of FSH & LH in both male & female - By mid-gestation → the female fetus acquires the lifetime peak number of Oocyte - Initial production of sex steroid from mature follicles (in utero) →high sensitivity for –ve feedback from sex steroids→ suppresses fetal sex steroid production (not affect maternal & placental production of sex steroids) & suppresses further follicular stimulation - The sensitivity to sex steroids will last strong until reaching prepubertal stage	
Neonatal onset	With birth, acute loss of –ve Feedback → release of FSH&LH once again	At 1 week of age sex steroid reach its prepubertal value
		At 3 months gonadotropins reach a peak then starts declining
		At 4 years gonadotropins reach its MIN. values
Childhood onset	4-10 years of age →still slow release of gonadotropins	
Late prepubertal onset	8-11 years → androgen production from adrenal cortex (DHEA..) is the initial endocrine changes associated with puberty , so called adrenarche	
Pubertal onset	-At 11 years , stops –ve feedback of sex steroids → pulses increase in amplitude & frequency of GnRH, FSH & LH - Develop of 2ry sexual characteristics - By middle to late puberty → maturation of +VE feedback mechanism of estradiol on LH releasefrom Anterior Pituitary gland is completed	

PUBERTY IN FEMALES

- Physical changes of puberty involve the development of 2ry sexual characteristics & acceleration if linear growth (gain in height)

- Concepts:

* adrenarche: is the initial endocrine changes associated with puberty →→

thelarche: is breast budding which is the 1st physical sign of puberty -→

pubarche: the appearance of pubic hair → Max. growth / peak height velocity →

menarche: the 1st menstrual period (occurs about 2-3 years after thelarche)→

the final somatic changes are appearance of adult pubic hair distribution & adult type breasts

PUBERTY IN FEMALES

TANNER STAGING (SEXUAL MATURITY RATING)

- Is an objective classification system that providers use to document & track the development and sequence of 2ry sex characteristics of children during puberty

- For descriptive and diagnostic purposes

Breast development

Stages as defined by **Marshall and Tanner.**

***Stage 1**, Preadolescent; elevation of papilla only.*

***Stage 2**, Breast bud stage; elevation of breast and papilla as a small mound with enlargement of the areolar region.*

***Stage 3**, Further enlargement of breast and areola without separation of their contours.*

***Stage 4**, Projection of areola and papilla to form a secondary mound above the level of the breast.*

***Stage 5**, Mature stage; projection of papilla only, resulting from recession of the areola to the general contour of the breast.*

Pubic hair

Stages according **to Marshall and Tanner:**

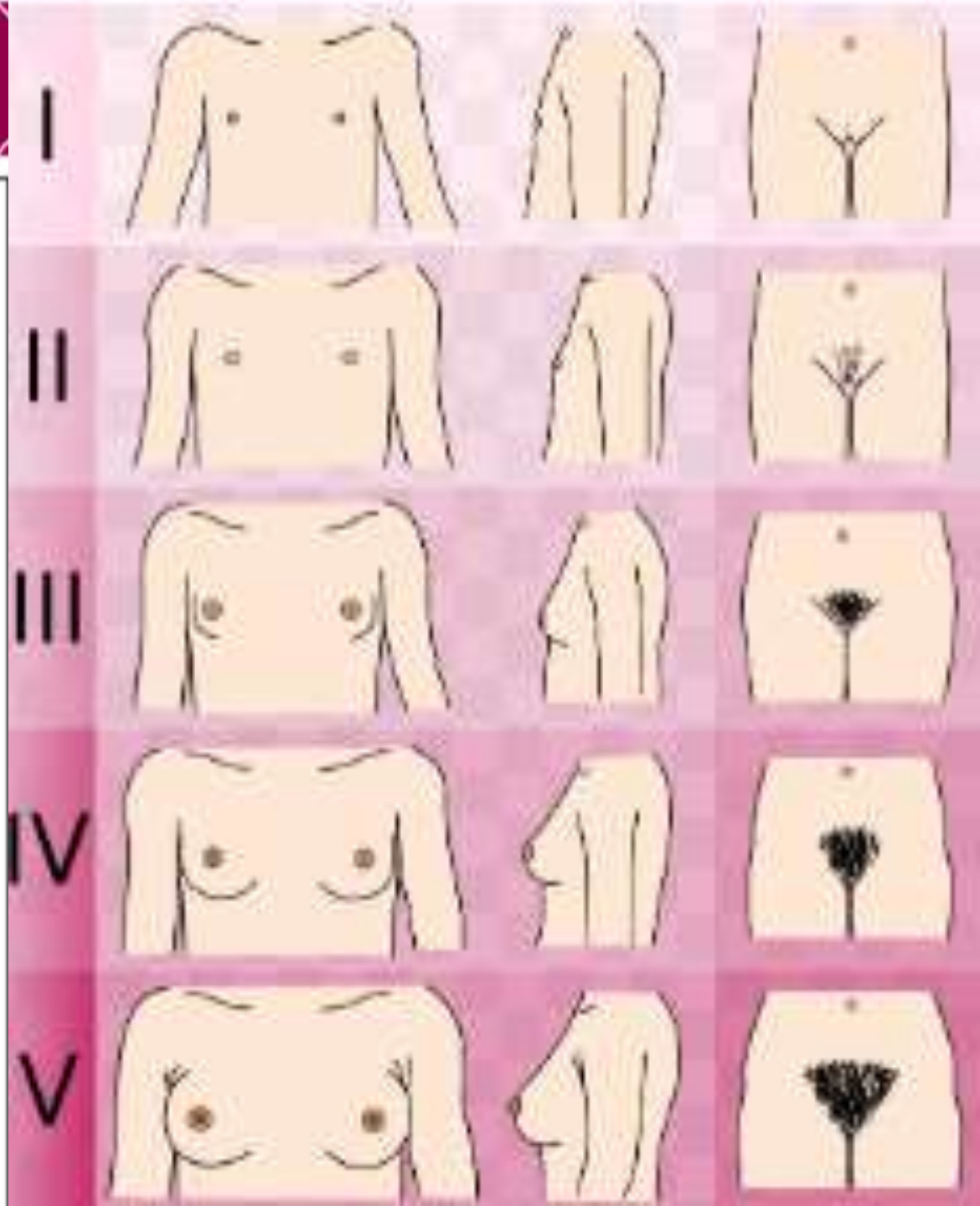
***Stage 1**, Preadolescent; absence of pubic hair.*

***Stage 2**, Sparse hair along the labia; hair downy with slight pigmentation.*

***Stage 3**, Hair spreads sparsely over the junction of the pubes; hair is darker and coarser.*

***Stage 4**, Adult-type hair; no spread to the medial surface of the thighs.*

***Stage 5**, Adult-type hair with spread to the medial thighs assuming an inverted triangle pattern.*



BODY COMPOSITION & BONE AGE

+ prepubertal boys & girls ➔ There are no significant differences in skeletal mass, lean body mass or percentage of body fat

+ after attaining sexual maturity➔ girls generally have les skeletal ,lean body mass **&** greater percentage of body fat (especially in the typical female distribution of breasts, hips, buttocks, thighs, upper arms & pubis)than boys

+ during this period in response to rising levels of estrogen → lower half of the pelvis & hips become wider

+ peak height velocity occurs approximately 1 year before the onset of menarche

after menarche there is limited linear growth , gonadal steroid accelerates the fusion of long bone epiphysis

+ bone age correlates well the onset of 2ry sexual characteristics & menarche

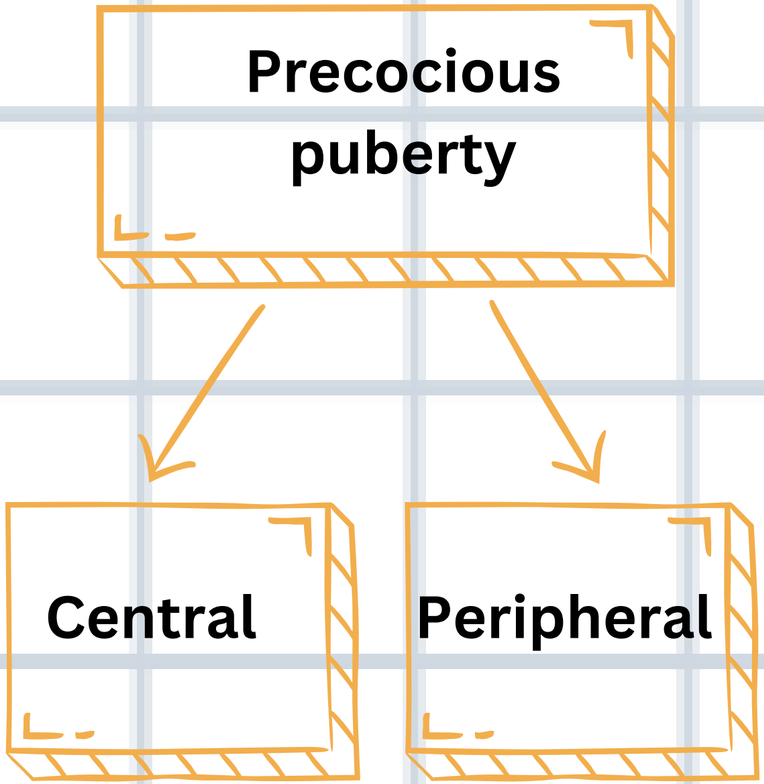
PRECOCIOUS PUBERTY

WHAT IS PRECOCIOUS PUBERTY?

- Precocious puberty: refers to the development of any sign of secondary sexual maturation at an age 2.5 standard deviations earlier than the expected age of pubertal onset.
- In North America, these ages are 8 years for girls and 9 years for boys.
- The incidence of precocious puberty is 1 in 10,000 children in North America, and it is approximately five times more common in girls.
- In 75% of cases of precocious puberty in girls, the cause is idiopathic

CLASSIFICATION

Depending on the primary source of the hormonal production,
precocious puberty may be classified as:



CENTRAL

- gonadotropin-dependent precocious puberty, true precocious puberty
- always Isosexual precocious puberty
- elevated GnRH levels
- **Pathophysiology**

Early activation of the hypothalamo-hypophyseal axis → abnormally early initiation of pubertal changes → early development of secondary sexual characteristics

ETIOLOGY

IDIOPATHIC

Most common cause

CNS LESIONS

- Intracranial tumors (e.g., hamartoma, glioma, craniopharyngioma)
- Trauma
- Infections (e.g., encephalitis, meningitis)
- Hydrocephalus

SYSTEMIC CONDITIONS

tuberous sclerosis, neurofibromatosis

RADIATION

DIAGNOSIS

LABORATORY TESTS

- Serum LH and FSH: **increased**
- GnRH stimulation test (**gold standard**): evaluates the reactivity of the hypothalamic-pituitary-axis to GnRH stimulation
  - (LH and FSH) levels **increase** after intravenous administration of GnRH.
- Serum testosterone/estradiol: **increased**

IMAGINING

- X-ray of the nondominant hand and wrist: allows comparison between skeletal maturation and chronological age
  - Assess and confirm accelerated bone growth.
  - Bone age is within 1 year of a child's age: Puberty likely has not started.
  - Bone age is > 2 years of the child's age: Puberty has been present for a year or longer.
- MRI/CT of the brain with contrast: when ↑ LH is confirmed
  - Perform in girls 6 years of age, all boys, and children with neurologic symptoms.
  - Rule out intracranial causative pathology.

TREATMENT

- **GnRH agonist** (e.g., leuprolide, buserelin, goserelin): to. prevent premature fusion of growth plates
  1-Close monitoring of therapy
  2- Follow-up is recommended every 4-6 months to assess progression.
- Manage underlying cause.

PERIPHERAL PRECOCIOUS PUBERTY

- Precocious puberty without elevated GnRH levels (due to ↑ peripheral synthesis of or exogenous exposure to sex hormones)
- High levels of sex hormones(Estrogen & Progesterone) >>Suppression hypothalamus (GnRH) >> suppression anterior pituitary (low LH, low FSH)

ETIOLOGY

1. congenital Adrenal Hyperplasia
2. Adrenal tumor
3. Androgen Secreting ovarian tumor
4. McCune-Albright syndrome
5. Exposure to exogenous Estrogen
6. Hypothyroidism

CONGENITAL ADRENAL HYPERPLASIA

- Result from decrease adrenal steroid synthesis enzymes So all hormonal precursors go to synthesis of sex hormones
- 21β-hydroxylase (95% of CAH) subtype is the most coone and it's responsible for precocious puberty
- Tx:cortisol replacement

PRIMAR HYPOTHYROIDISM

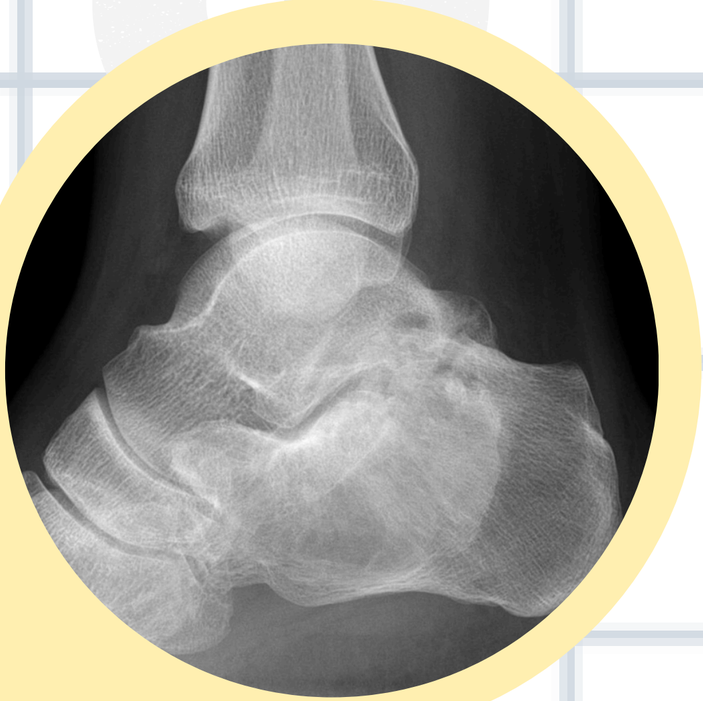
- Pituitary gonadotropin release In response to Persistent elevation of TRH (concomitant Elevation of prolactin may occur (galactorrhea)
- Dx :TFT
- Tx : thyroxine

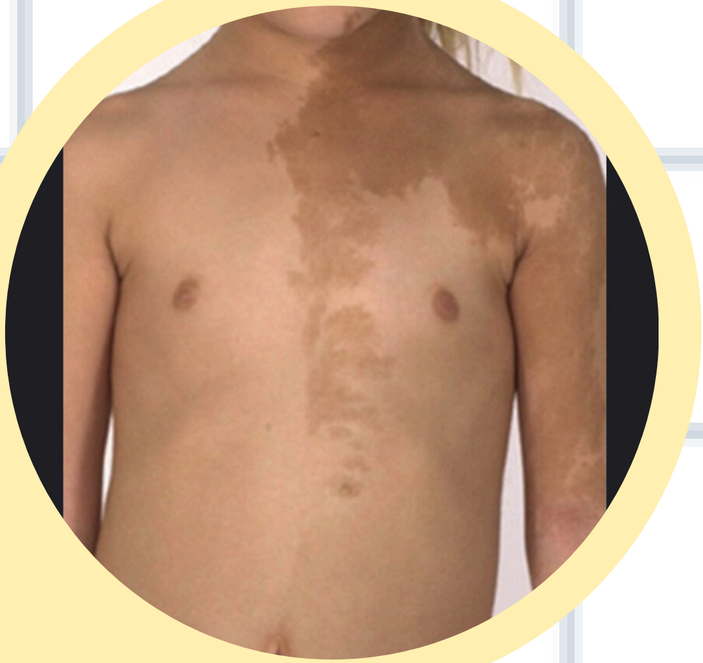
ANDROGEN SECRETING OVARIAN TUMOR

- (sex cord stormal ovarian tumors)
- Dx by Pelvic ultrasound
- Tx Surgical removal

MCCUNE ALBRIGHT SYNDROME

- A genetic syndrome caused by a G-protein activating mutation and subsequent continuous stimulation of endocrine functions
- **3 P:are P**olyostotic fibrous dysplasia, **P**igmentation (café-au-lait spots), and **P**recocious puberty.
- Tx: Tamoxifen





DIAGNOSIS

LABORATORY TESTS

- Serum LH and FSH: **deccreased**
- GnRH stimulation test (**gold standard**): evaluates the reactivity of the hypothalamic-pituitary-axis to GnRH stimulation
- **No increase** in LH levels after GnRH administration.
- Serum testosterone/estradiol: **increased**

IMAGINING

- X-ray of the nondominant hand and wrist: accelerated bone growth
- Ultrasound of the ovaries, testicles, and abdomen (cases of increased ovarian and/or uterine volume than expected for age, diagnostic uncertainty)

DELAYED PUBERTY

WHAT IS DELAYED PUBERTY?

- Puberty that happens late is called delayed puberty. This means a child's physical signs of sexual maturity don't appear by age 12 in girls or age 14 in boys. This includes breast or testicle growth, pubic hair, and voice changes.

CAUSES OF PUBERTY DELAY

- The causes of delayed onset of puberty can be divided into:
- Pathological delay(Primary & Secondary Hypogonadism)
- Physiological delay (Constitutional delay)

PRIMARY HYPOGONADISM (HYPERGONADOTROPIC HYPOGONADISM)

- Decrease or absence of sex hormones due to dysfunction in the gonads, despite high gonadotrophins.
- Cells cannot respond to FSH and LH or cells cannot produce hormones.
- The result is a decrease or absence of estrogen and progesterone in females and testosterone in males so NO negative feedback on the hypothalamus, leads to overproduction of LH and FSH.

CAUSES OF PRIMARY HYPOGONADISM :

- Congenital: Turner syndrome, and Klinefelter syndrome.
- Acquired: following chemo- or radiotherapy for childhood cancer, or trauma to the gonads.

SECONDARY HYPOGONADISM (HYPOGONADOTROPIC HYPOGONADISM)

- Defined as Hypothalamus & pituitary dysfunction. So Inability to produce GnRH, LH & FSH, or Suppression from other hormones like prolactin & and thyroid hormones.

CAUSES OF SECONDARY HYPOGONADISM

- Acquired: radiotherapy, chemotherapy, trauma.
- Congenital: Kallmann syndrome and Panhypopituitarism
- General: anorexia nervosa, excessive exercise, stress (all this increases cortisol production which decreases sensitivity of the pituitary to the GnRH), Malnutrition, Obesity.
- Tumors: prolactinoma, craniopharyngioma

KALLMANN SYNDROME

(Hypogonadotropic hypogonadism and anosmia)

Normal height

Normal external and internal genital organs (infantile)

Result from a mutation of the KAL gene on the X chromosome or from autosomal mutations that prevent the embryologic migration of GnRH neurons into the hypothalamus.

- Diagnosis:
- Hormones level: ↓ GnRH ↓LH ↓FSH ↓ ESTROGEN ↓ PROGESTERON normal level of other pituitary gland
- Genetic test
- Smell test
- Normal pituitary and hypothalamus on MRI
- Treatment: HRT.

Kallman Syndrome

defective migration of GnRH cells

↓↓ GnRH in the hypothalamus

↓↓ GnRH
↓↓ FSH
↓↓ LH
↓↓ testosterone

♂ ♀

low sperm count

Amenorrhea

I can't reproduce

defective formation of olfactory bulb

ANOSMIA

CRANIOPHARYNGIOMA

- A benign tumor arising from a remnant Rathke pouch (embryological origin for anterior pituitary gland)
- Most common childhood supratentorial tumor
- The tumor arises in the suprasellar region and can extend into the intrasellar region.
- (Compression symptoms):
- Compression of the pituitary gland due to intrasellar extension → hypopituitarism (Hypogonadotropic hypogonadism, Failure to thrive, central diabetes insipidus)

PROLACTINOMA

- Benign Tumor (Adenoma) of the pituitary gland that secretes excess prolactin hormon.
- Signs & Symptoms:
- Amenorrhea,Galactorrhea ,Gynecomastia, decrease Libido, infertility.
- Complications:
- 1.Loss of vision & headache (if left untreated a prolactinoma may grow large enough to compress your optic nerve).
- 2.Osteoporosis & fractures (low level of estrogen Will decrease bone density).

DIAGNOSIS AND TREATMENT OF PROLACTINEMIA

- **Diagnosis:**
- CT & MRI
- Prolactin serum level >100 ng/mL
- **Treatment:**
- Pharmacotherapy: dopamine agonists (cabergoline)
- Surgery
- Radiation

CONSTITUTIONAL DELAY

- Temporary delay puberty (puberty onset and progression can be normal, it only happens later in age).
- Caused by immature pulsatile release of gonadotrophin-releasing hormone.
- Slow rate of maturation, not pathological.
- Do not cause infertility.
- Typically, genetic components (run in the family).
- Do not require treatment.

DIAGNOSIS OF DELAYED PUBERTY

- Comparing the individualized sexual development with Tanner scale
- Detailed medical history (underlying medical illness and family history)
- Radiological image
- Hormone test (Type of Hypogonadism)
- Karyotype (to examine chromosomes, identify genetic problems)