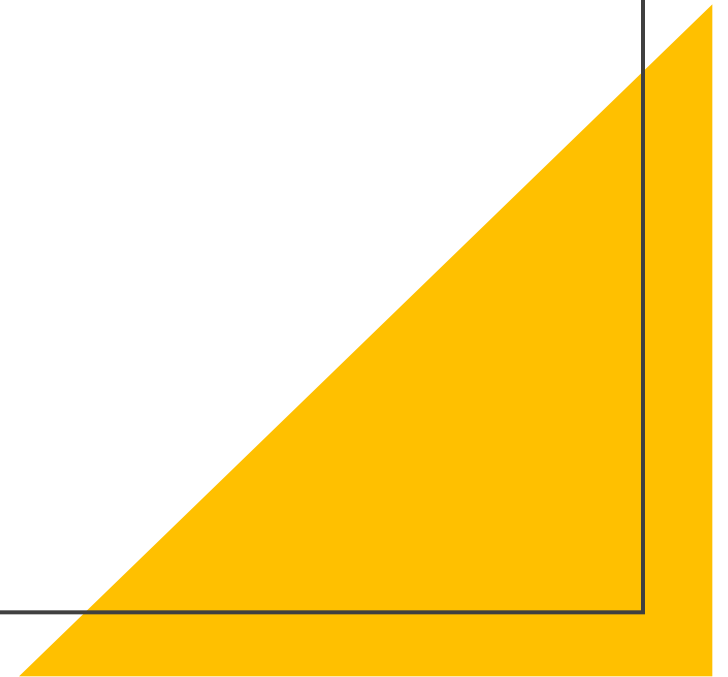


# Anatomy of penis, and Physiology of erection, Erectile Dysfunction

Dr. Fadi Sawaqed  
Associate professor  
Functional and Neuro-Urology

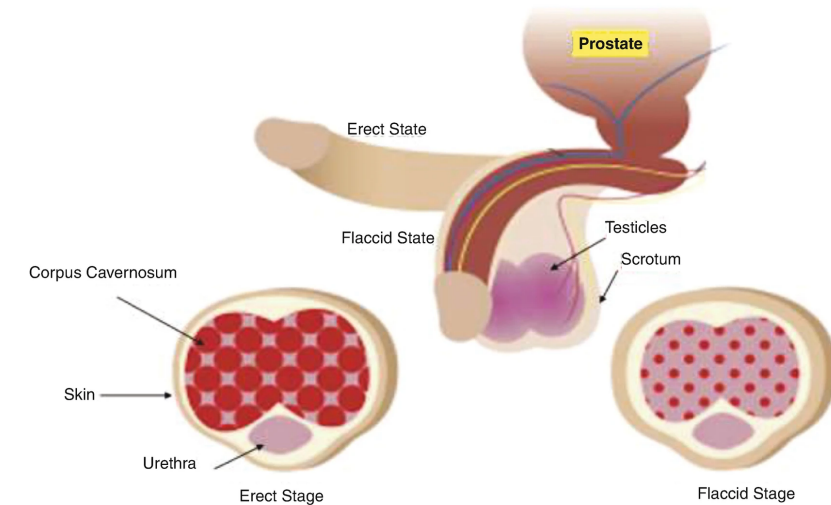


# Penile Erection: Anatomy

- penis is divided into three parts: root (radix), body (shaft), and glans
- The root is the proximal part of the penis located in the urogenital triangle. It consists of two muscles (ischiocavernosus and bulbospongiosus) and the crura and the bulb of penis which represent proximal expansions of the erectile tissues.
- The body of penis is enveloped in skin and in three fasciae (dartos, buck, and tunica albuginea).

The body of the penis contains three erectile tissues: the two corpora cavernosa and the corpus spongiosum

The glans is the most distal part of the penis. It is a sensitive structure at the end of the body of penis which gets its shape from the bulbous expansion of the corpus spongiosum

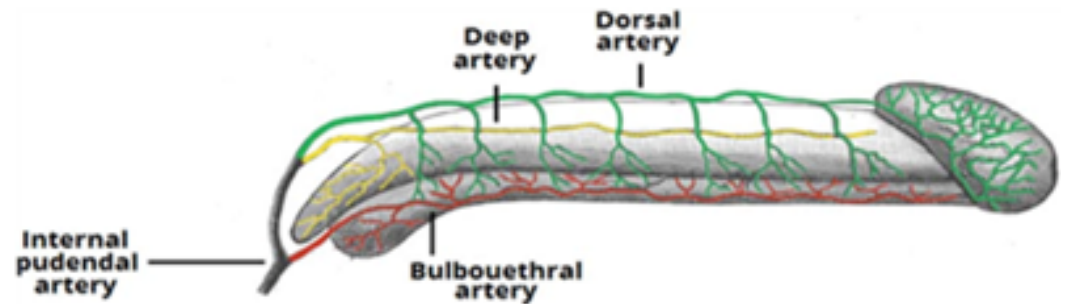


# Penile Erection: Innervation

- The penis is characterized by autonomic (sympathetic and parasympathetic) and somatic (sensory and motor) innervation system.
- The autonomic system regulates the neurovascular events occurring during erection and detumescence.
  - The sympathetic system originates from T10-T12, and the chain ganglia cells projecting to the penis are located in the sacral and caudal ganglia.
  - The parasympathetic system arising from neurons in the intermediolateral cell columns of S2-S4 is carried by cavernous nerves from the peri-prostatic nerve plexus.
- The somatic system is responsible for sensation and the contraction of the bulbocavernosus and ischiocavernosus muscles (S2-S4 via pudendal nerve)

# Penile Erection: Arterial supply

- Three sources originated by internal pudendal arteries:
  - dorsal arteries of the penis,
  - deep arteries of the penis,
  - bulbourethral artery.



- The first supply the fibrous tissue surrounding the corpora cavernosa, corpus spongiosum, spongy urethra, and penile skin .
- The second supply the erectile tissue of the penis,
- Arteries of the bulb of the penis supply the bulbous part of the corpus spongiosum, urethra, and bulbourethral gland.
- The penile skin is supplied by superficial and deep branches of the external pudendal arteries.

# Penile Erection: venous & lymphatic system

- The deep dorsal vein of the penis which receives blood from the cavernous spaces.
- The superficial dorsal vein which drains blood from the skin and subcutaneous tissue of the penis.
- Regarding the lymphatic system,
  - the penis skin and all the perineum drain into superficial inguinal nodes.
  - The intermediate and proximal parts of the urethra and cavernous bodies drain into the internal iliac lymph nodes,
  - the distal spongy urethra and glans penis drain to the deep inguinal nodes.

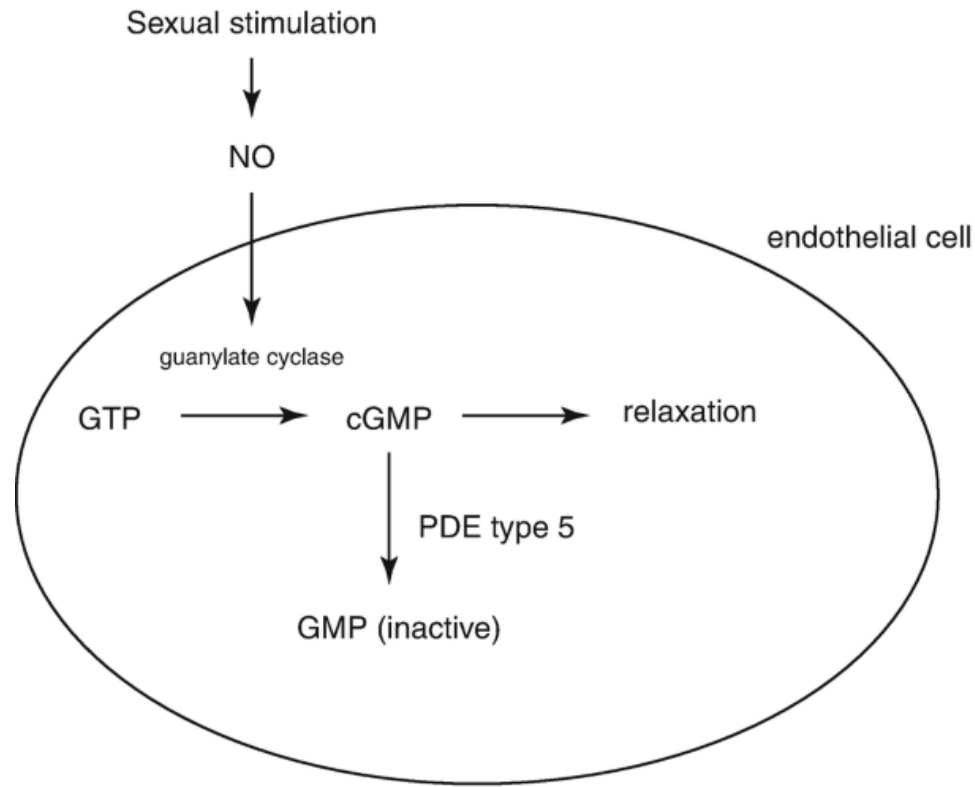
# Mechanism of erection

- Three types of erection have been described:
  - **Nocturnal**, that follows the rapid eye movement sleep periods;
  - **Reflexogenic** due to genital stimulations;
  - **The central or psychogenic** related to many stimulations trigger points (imaginative, visual, auditory, olfactory, gustatory, tactile, etc.)

# Mechanism of erection

- The erectile process involves specifically the cavernous smooth musculature and the smooth muscles of the arteriolar and arterial walls.
- In the flaccid state, there is a tonic contraction of these structures.
- The relaxing of smooth muscle resulting in increase of intracavernosal pressure that leads to compression of the subtunical venules against the tunica albuginea.
- This reduces venous drainage from the corpora cavernosa and increases pressure within the corpora. **the veno-occlusive mechanism**

# Mechanism of erection



NO= nitric oxide  
cGMP= cyclic guanosine monophosphate  
PDE= phosphodiesterase

- The stimulation result in the relaxation of smooth muscles of corpus cavernosum which leads to increase in the blood flow.
- This process is mediated by Nitric oxide(NO) which activates Guanylyl cyclase which forms Cyclic guanosine monophosphate(cGMP) from guanosine triphosphate(GTP),cGMP produces smooth muscle relaxation and decreases intracellular Ca concentration.
- The duration of action of cGMP is controlled by Phosphodiesterase (PDE),specially PDE-5 which is the isozyme responsible for the termination of cGMP in the corpus cavernosum.



# Mechanism of erection

- Dilatation of the arterioles and arteries by increased blood flow
- Trapping of the incoming blood by the expanding sinusoids
- Compression of the subtunical venular plexuses between the tunica albuginea and the peripheral sinusoids, reducing the venous outflow
- Stretching of the tunica to its capacity, which occludes the emissary veins between the inner circular and the outer longitudinal layers and further decreases the venous outflow to a minimum
- An increase in PO<sub>2</sub> (to about 90 mmHg) and intracavernous pressure (around 100 mmHg), which raises the penis from the dependent position to the erect state (the full-erection phase)
- A further pressure increase (to several hundred millimeters of mercury) with contraction of the ischiocavernosus muscles (rigid-erection phase)

# Phases of erectile process

phase	term	description
0	Flaccid phase	Cavernosal smooth muscle contracted; sinusoids empty; minimal arterial flow
1	Latent (filling ) phase	Increased pudendal artery flow; penile elongation
2	Tumescent phase	Rising intracavernosal pressure; erection forming
3	Full erection phase	Increased cavernosal pressure causes penis to become fully erect
4	Rigid erection phase	Further increases in pressure + ischiocavernosal muscle contraction
5	Detumescence phase	Following ejaculation, sympathetic discharge resumes; there is smooth muscle contraction and vasoconstriction; reduced arterial flow; blood is expelled from sinusoidal spaces

# Pathophysiology of Erectile Dysfunction

- Erectile dysfunction (ED) is defined as the persistent inability to attain and/or maintain penile erection sufficient to permit satisfactory sexual performance
- Erectile dysfunction may affect physical and physiological health and has a strong impact on quality of life and relationships.
- It is recognized as a possible early sign of coronary artery and peripheral vascular disease. Therefore, physicians should ask male patients about sexual health in order to identify potential life-threatening underlying conditions such as cardiovascular disease

# Classification: Organic

## I. Vasculogenic

A. Arteriogenic

B. Cavernosal

C. Mixed

## II. Neurogenic

## III. Anatomic

## IV. Endocrinologic

# Classification: Psychogenic

## **I. Generalized**

### **A. Generalized unresponsiveness**

1. Primary lack of sexual arousability
2. Aging-related decline in sexual arousability

### **B. Generalized inhibition**

1. Chronic disorder of sexual intimacy

## **II. Situational**

### **A. Partner-related**

### **B. Performance-related**

### **C. Psychological distress- or adjustment-related**

# Psychogenic Vs Organic

<i>Characteristic</i>	<i>Predominantly psychogenic ED</i>	<i>Predominantly organic ED</i>
Onset	Acute	Gradual
Circumstances	Situational	Global
Course	Intermittent	Constant
Noncoital erection	Rigid	Poor
Nocturnal/early morning	Normal	Inconsistent
Psychosexual problems	Long history	Secondary to ED
Partner problems	At onset	Secondary to ED
Anxiety/fear	Primary	Secondary to ED

ED: erectile dysfunction

# History

- **Sexual:** onset of ED (sudden or gradual); duration of problem; presence of erections (nocturnal, early morning, spontaneous); ability to maintain erections (early collapse, not fully rigid); loss of libido; relationship issues (frequency of intercourse and sexual desire).
- **Sexual function symptom questionnaires:** International Index of Erectile Function (IIEF)
- **Medical and surgical:** enquire about risk factors, including diabetes mellitus (ED affects 50% overall and 30% of treated diabetics); cardiovascular disease; hypertension; peripheral vascular disease; endocrine or neurological disorders; pelvic and penile surgery, radiotherapy, or trauma (which damage innervation and blood supply to the pelvis and penis).
- **Psychosocial:** assess for social stresses, anxiety, depression, coping problems, patient expectations, and relationship details.
- **Drugs:** enquire about current medications and ED treatments already tried and their outcome.
- **Social:** smoking, alcohol consumption.

# Examination

- Full physical examination (cardiovascular, abdomen, neurological)
- DRE to assess the prostate; assess secondary sexual characteristics
- external genitalia assessment to document foreskin phimosis, penile deformities and lesions (Peyronie's plaques); confirm presence, size, and location of testicles.
- The bulbocavernosus reflex can be performed to test integrity of spinal segments S2–4 (squeezing the glans causes anal sphincter and bulbocavernosal muscle contraction).



## Investigation

- 1. Blood tests:** fasting glucose; serum (free) testosterone (taken 8.00–11.00 a.m.); fasting lipid profile are basic work-up tests. SHBG; U&E; LH/FSH; prolactin; PSA; thyroid function test should be selected according to patient's history and risk factor profile.
- 2. Nocturnal penile tumescence and rigidity testing:** the Rigiscan device contains two rings that are placed around the base and distal penile shaft to measure tumescence and number, duration, and rigidity of nocturnal erections. Useful for diagnosing psychogenic ED and for illustrating this diagnosis to patients.
- 3. Penile colour Doppler USS:** measures arterial peak systolic and end diastolic velocities, pre- and post-intracavernosal injection of PGE1.
- 4. Cavernosography:** imaging and measurement of penile blood flow after intracavernosal injection of contrast and induction of artificial erection, used to identify venous leaks.
- 5. Penile arteriography:** reserved for trauma-related ED in younger men. Pudendal arteriography is performed before and after drug-induced erection to identify those requiring arterial bypass surgery (although this is less commonly indicated now with the advent of modern penile prostheses).
- 6. - MRI:** useful for assessing penile fibrosis and severe cases of Peyronie's disease.

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# Investigation : Nocturnal penile tumescence

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# Treatment

- Correct any reversible causes (i.e. alter lifestyle, stop smoking, change medication, etc.)
- **Psychosexual therapy**
  - sex education, psychosexual counselling
  - instruction on improving partner communication skills
  - cognitive therapy and behavioural therapy (programmed relearning of couple's sexual relationship).
  - Pharmacotherapy may be a useful adjuvant.

# 1-Phosphodiesterase type-5 (PDE5) inhibitors:

## first-line therapies

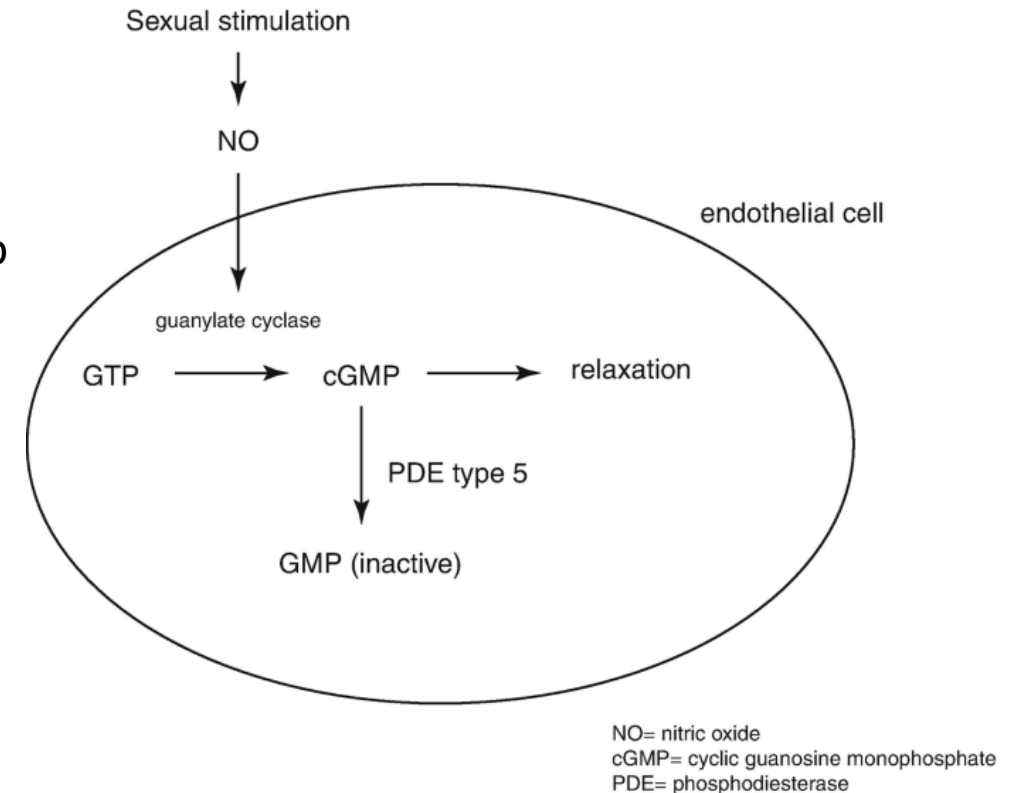
sildenafil (Viagra), tadalafil (Cialis), vardenafil (Levitra)

- enhance cavernosal smooth muscle relaxation
- **by blocking the breakdown of cGMP by phosphodiesterase.**
- Sexual stimulus is still required to initiate events.
- Success is reported in up to 80%.
- Early use of PDE5 inhibitors following radical prostatectomy can help optimize the return of spontaneous erections (penile rehabilitation).

## Contraindications:

- *patients taking nitrates*
- *recent myocardial infarction*
- recent stroke
- hypotension
- unstable angina, non-arteritic anterior ischaemic
- optic nerve neuropathy (NAION).
- *Cautions: intermediate and high-risk cardiovascular disease requires cardiac review prior to treatment*

**use with A-blockers, groups with predisposition to priapism.**

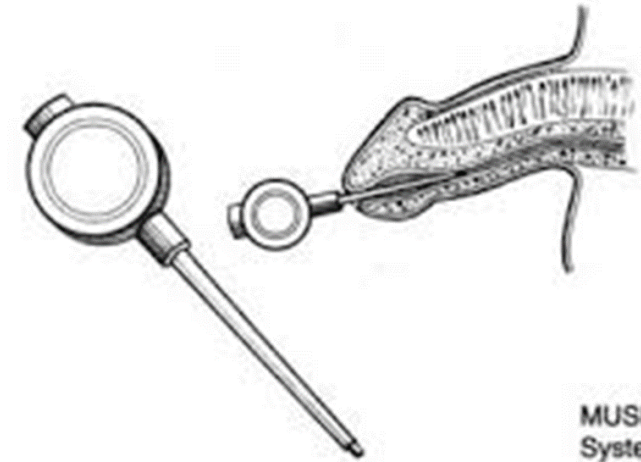


## *2-Dopamine receptor agonist:*

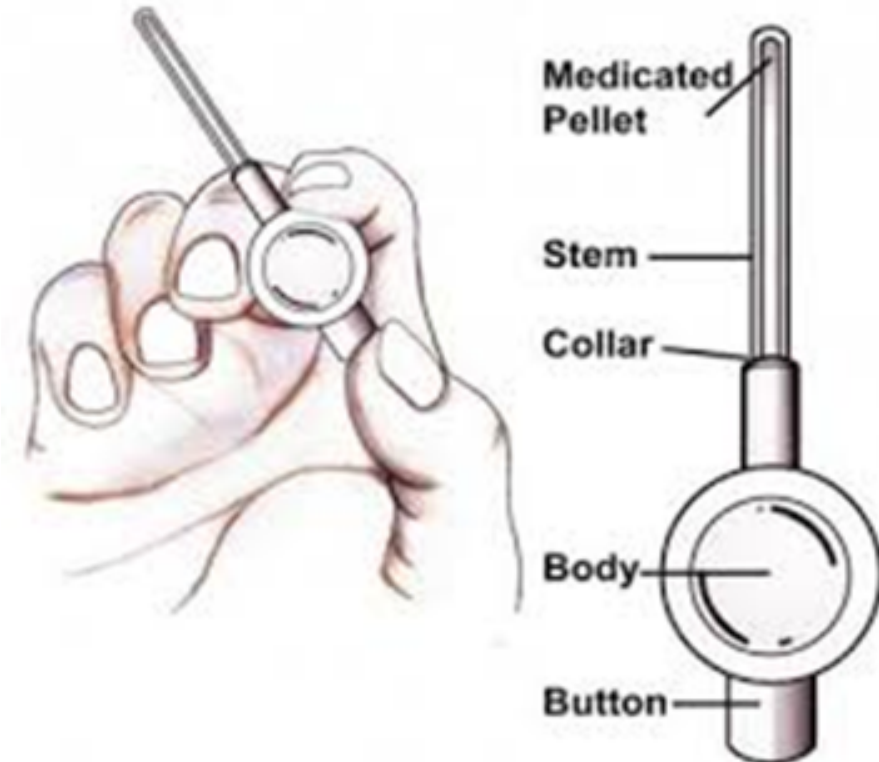
- *apomorphine (UprimaR)*
- *taken **sublingually***
- *acts centrally on dopaminergic receptors in the paraventricular nucleus of the hypothalamus*
- *enhance and coordinate the effect of sexual stimuli.*
- *Side effects: nausea, headache, dizziness*
- *Not commonly used*

## 3-Intraurethral therapy:

- second-line therapy when oral therapies have been ineffective.
- **A synthetic prostaglandin E1 (PGE1) pellet (alprostadil)**
- placed into the urethra via a specialized applicator (Medicated Urethral System for Erection (MUSE)™ device).
- Once inserted, the penis is gently rolled to encourage the pellet to dissolve into the urethral mucosa from where it enters the corpora.
- **PGE1 acts to increase cAMP within the corporal smooth muscle, resulting in muscle relaxation.**
- *Side effects: penile and urethral pain, priapism, local reactions.*

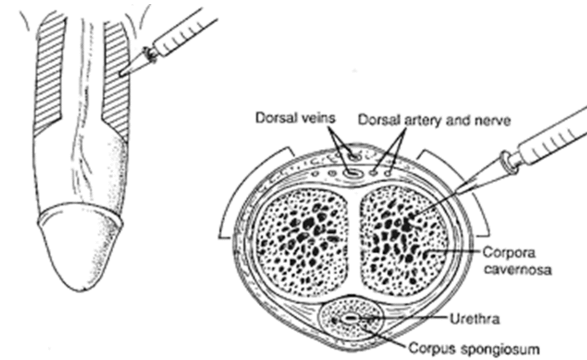


MUSE (Medical Urethral System for Erection)



## 4-Intracavernosal injection therapy

- **Alprostadil (Caverjet™).**
- **Papaverine (PDE inhibitor).**
- Usually given in combination with either phentolamine (A-adrenoceptor antagonist) or PGE1
- Who have failed oral or single-agent injectable therapies.
- Training of technique and first dose is given by a health professional.
- Needle is inserted at right angles into the corpus cavernosum on the lateral aspects of mid-penile shaft.
- Discontinuation rates from penile injection techniques are high.
- ***Contraindications: sickle cell disease or high-risk candidate for priapism.***
- ***Adverse effects: pain, priapism, haematoma***





## Vacuum erection device

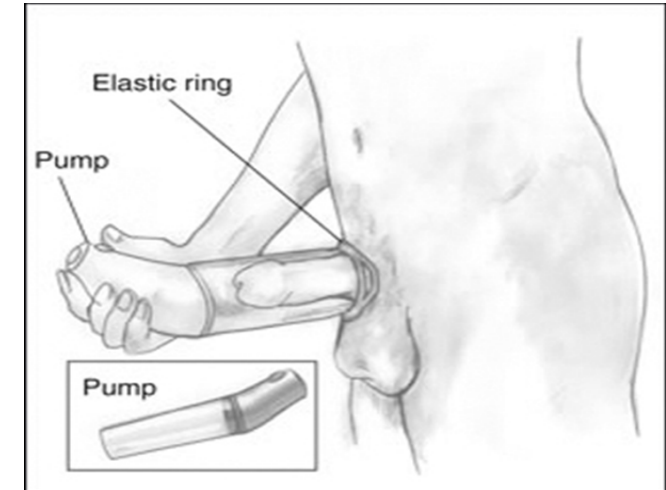
- Used when pharmacotherapies have failed.
- It contains three components: a vacuum chamber, pump, and constriction band
- The penis is placed in the chamber and the vacuum created by the pump increases blood flow to the corpora cavernosa to induce an erection.
- The constriction band is placed onto the base of the penis to retain blood in the corpora and maintain rigidity.
- *Relative contraindication: anticoagulation therapy.*
- *Side effects: penile coldness, bruising.*

## Microvascular arterial bypass and venous ligation surgery

*Used in: specialist centres where there is a clear-cut diagnosis of a vascular disorder.*

Acts to increase arterial inflow and decrease venous outflow.

Rarely used now as it is uncommon for success rates to exceed 50%.



## Penile prosthesis

- Semi-rigid, malleable, and inflatable penile prostheses
- other therapies have failed or are unsuitable
- Also indicated for Peyronie's disease, trauma, and penile fibrosis (i.e. secondary to priapism).
- The device is surgically implanted into the corpora to provide penile rigidity and generally has high satisfaction rates, up to 90%
- *Side effects: infection, erosion, mechanical failure, penile shortening, glans may not fully engorge.*

## Testosterone replacement therapy

- Indicated for hypogonadism
- available in oral, buccal, intramuscular, pellet, transdermal patch, and gel forms.
- Most guidelines recommend PSA, Hb, and LFT checks before and after starting treatment
- It can improve the results of PDE5 inhibitors in hypogonadal men.

SOFT PENILE IMPLANT



MALLEABLE PENILE IMPLANT



INFLATABLE PENILE IMPLANT



Thank you

