Priapism Team-based Learning

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ABSTRACT:

Audience: This classic team-based learning (cTBL) module is designed for emergency medicine residents.

Introduction: Priapism is a rare but potentially irreversibly damaging condition if not evaluated and treated appropriately.[1] Several types of priapism exist: non-ischemic, stuttering, and ischemic. These types are dependent on etiology and pathophysiology of condition. Common causes of non-ischemic priapism are trauma resulting in arteriolar-sinusoidal fistulas, congenital arterial malformations, or iatrogenic insults.[1] Common causes of stuttering and ischemic priapism are similar, and consist of idiopathic insults, alpha-agonist medications, and hematological disorders.[1] Ischemic priapism leads to compartment syndrome, which needs immediate intervention. Understanding the varying etiologies is important because unnecessary intervention may lead to significant patient morbidity.[2] The time course of condition is also a crucial variable to consider when formulating a treatment plan, so understanding a basic algorithm for management will increase rates of detumescence and decrease rates of fibrosis and erectile dysfunction.[3] Emergency medicine physicians should feel comfortable evaluating and treating all types of priapism, but due to its low incidence rate, rarely have adequate exposure during residency. This team-based learning module will review the appropriate management and treatment of priapism in an acute setting.

Objectives: By the end of this cTBL, the learner will: 1) identify basic penile anatomy, 2) understand pathophysiology behind the varying types of priapism – ischemic, non-ischemic, and stuttering, 3) discuss how to evaluate priapism etiology, 4) recognize how varying priapism types, time course, and mechanism of injury will alter treatment regimen, and 5) know how to administer the appropriate treatment.

Method: This module is a cTBL which consists of pre-class preparation, individual readiness assessment test (iRAT), group readiness assessment test (gRAT), group application exercise (GAE), and a brief wrap-up of session.

Topics: Priapism, urological emergency, erectile dysfunction, sickle cell disease, perineal trauma, alpha-adrenergic agonists, sympathomimetics, compartment syndrome

USER GUIDE

List of Resources:

Learner Audience:
Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:
Instructor Preparation: 30 minutes
Learner Responsible Content: 0-60 minutes
In Class Time: 60-90 minutes

Recommended Number of Learners per Instructor:
Ideally groups less than 30 people, but can also accommodate larger audience if necessary.

Topics:
Priapism, urological emergency, erectile dysfunction, sickle cell disease, perineal trauma, alpha-adrenergic agonists, sympathomimetics, compartment syndrome.

Objectives:
By the end of this cTBL, the learner will:

1. Identify basic penile anatomy.
2. Understand pathophysiology behind the varying types of priapism – ischemic, non-ischemic, and stuttering.
3. Discuss how to evaluate priapism etiology.
4. Recognize how varying priapism types, time course, and mechanism of injury will alter treatment regimen.
5. Know how to administer the appropriate treatment.

Linked objectives, methods and results:
Learners will establish a baseline understanding of priapism and the medical management of the condition through the readiness assessment tests (objective 1 and 2). Learners will then apply this knowledge in a workup of a theoretical patient with a specific type of priapism during the group application exercise (objectives 3 and 4), and then discuss the best treatment for this patient (objective 5). Learners will also consider alternative treatment options when their initial treatment fails (objectives 4 and 5). Learners will confirm their understanding of priapism and various treatment options through a post-test assessment, and have the opportunity to inquire further during the wrap-up.

Recommended pre-reading for instructor:
The instructor should feel comfortable with all answers and explanations within this module. Below are several resources to quickly refresh on the basics of priapism and medical management of the condition.

- Salonia A, Eardley I, Giuliano F, et al. European Association of Urology guidelines on priapism. *Eur Urol*. 2014;65(2):480-489. doi: 10.1016/j.eururo.2013.11.008
- Pickens A. Priapism. EM in 5. In: YouTube. https://www.youtube.com/watch?v=73c8-GwE6tY. Published January 10, 2014. Accessed December 22, 2018.
- Mellick L. A Priapism aspiration and irrigation system. In: YouTube. https://www.youtube.com/watch?v=tDBHkA_EQ7s. Published March 8, 2016. Accessed December 22, 2018.

Learner Responsible Content (LRC):
The learner would benefit from reviewing the resources below prior to the session:

- Pickens A. Priapism. EM in 5. In: YouTube. https://www.youtube.com/watch?v=73c8-GwE6tY. Published January 10, 2014. Accessed December 22, 2018.
- Mellick L. A Priapism aspiration and irrigation system. In: YouTube. https://www.youtube.com/watch?v=tDBHkA_EQ7s. Published March 8, 2016. Accessed December 22, 2018.

Results and tips for successful implementation:
This priapism TBL was tested on a group of 10 learners. As a result of feedback from the session, we eliminated one of the group application exercise (GAE) questions. Of the 10 learners, 6 completed an evaluation form. The overall session was rated an average of 4.33 on a 5-point Likert scale, with 5 being outstanding; 4, excellent; 3, good; 2, fair; 1, poor. Most evaluators (66%) rated the session as highly relevant (4/4 Likert) and 33% of evaluators rated the session as mostly relevant (3/4 Likert).

One week prior to the session, learners should be emailed the learner responsible content (LRC); learners should be reminded two days before the session.

USER GUIDE

You will need approximately one hour to conduct the session. We recommend group sizes of two to four learners. The following timeline was successful for our program:

1. Introduce session (1 minute).
2. Learners complete the iRAT (5-10 minutes; this step can be eliminated if short on time and learners can immediately start with gRAT).
3. Place learners in groups of two to four learners.
4. Groups complete the gRAT (5-10 minutes).
5. Review gRAT answers using powerpoint and instructor RAT answer key (10 minutes).
6. Groups complete the GAE (20 minutes).
7. Instructor reviews the GAE using powerpoint (20 minutes).

References/suggestions for further reading:

1. Montague O, Jarrow J, Broderick G, et al. *Priapism: Guidelines to the Management of Priapisms.* American Urological Association Education and Research, Inc. 2003. https://www.auanet.org/guidelines/male-sexual-dysfunction-priapism-(2003-reviewed-for-currency-2010). Updated 2010. Accessed December 25, 2018.
2. AlDallal S, AlDallal N, & Alam A. Sickle cell-induced ischemic priapism. *Cogent Medicine*. 2016;3(1):1-12. doi: 10.1080/2331205X.2016.1268357
3. Al-Qudah H, Parraga-Marquez M, Santucci RA, Al-Omar O. Priapism treatment and management. *Medscape*. https://emedicine.medscape.com/article/437237-treatment. Updated November 28, 2016. Accessed December 22, 2018.
4. O'Sullivan M, Mislovic B, Alexander E. Dorsal penile nerve block for male pediatric circumcision – randomized comparison of ultrasound-guided vs anatomical landmark technique. *Pediatr Anesth*. *2011;21*(12):1214-1218. doi: 10.1111/j.1460-9592.2011.03722.x
5. Salonia A, Eardley I, Giuliano F, et al. European Association of Urology guidelines on priapism. *Eur Urol*. 2014;65(2):480-489. doi: 10.1016/j.eururo.2013.11.008

LEARNER MATERIALS

Priapism:
individual Readiness Assessment Test (iRAT)

1. Match each term with the appropriate number:

___ Corpus Cavernosum

___ Corpus Spongiosum

___ Deep Dorsal Vein

___ Dorsal Artery

___ Dorsal Nerve

___ Urethra

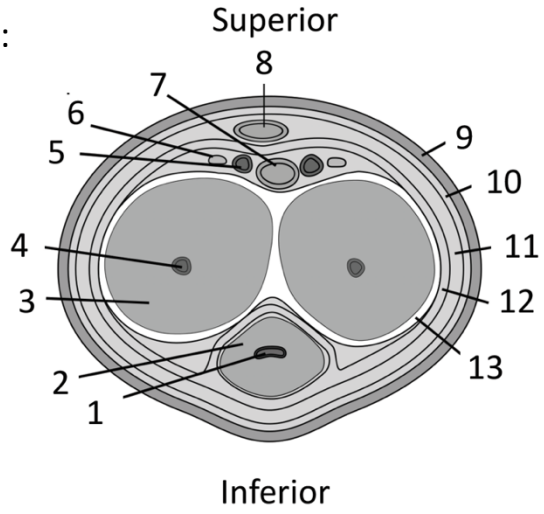

Image Source: Mcstrother. Cross section of penis with emphasis on fascial layers. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Penis_cross_section.svg. Published June 9, 2013. CC BY 3.0.

2. There are three types of priapism, each with a few synonyms; match each term with its synonym(s) and definition:

Arterial	High flow	Intermittent	Ischemic
Low Flow	Nonischemic	Stuttering	Veno-occlusive

Type of Priapism	Synonym #1	Synonym #2	Definition
			An urologic emergency characterized by a painful, persistent, fully rigid erection with little to no cavernous blood flow.
			Persistent erection caused by unregulated cavernous arterial inflow of blood often following trauma.
			A recurrent form of ischemic priapism, where erections occur repeatedly.

3. Typically only the _____ is/are affected in priapism.
    a. Corpora Cavernosa
    b. Corpora Spongiosum

4. If one were to perform a blood gas on the (answer to #3) in ischemic priapism, the blood gas would be:
    a. Similar to a normal arterial blood gas
    b. Hypoxic, hypercarbic, and acidotic
    c. Similar to a normal mixed venous blood gas

5. If one were to perform a blood gas on the (answer to #3) in nonischemic priapism, the blood gas would be:
    a. Similar to a normal arterial blood gas
    b. Hypoxic, hypercarbic, and Acidotic
    c. Similar to a normal mixed venous blood gas

Ultrasound may also be helpful in differentiating between ischemic and nonischemic priapism.

Priapism:
group Readiness Assessment Test (gRAT)

1. Match each term with the appropriate number:

___ Corpus Cavernosum

___ Corpus Spongiosum

___ Deep Dorsal Vein

___ Dorsal Artery

___ Dorsal Nerve

___ Urethra

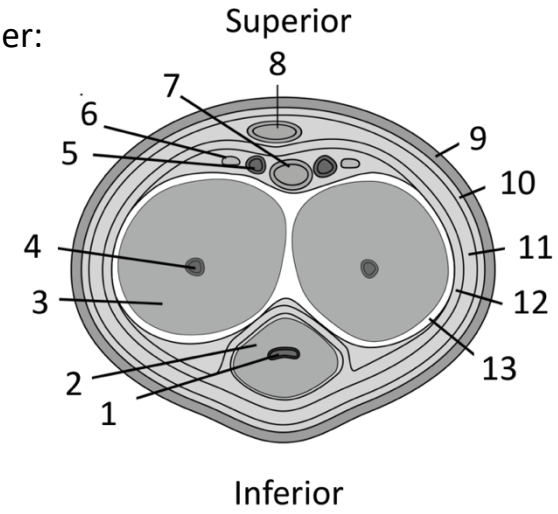

Image Source: Mcstrother. Cross section of penis with emphasis on fascial layers. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Penis_cross_section.svg. Published June 9, 2013. CC BY 3.0.

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    b. Hypoxic, hypercarbic, and acidotic
    c. Similar to a normal mixed venous blood gas

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    a. Similar to a normal arterial blood gas
    b. Hypoxic, hypercarbic, and acidotic
    c. Similar to a normal mixed venous blood gas

Ultrasound may also be helpful in differentiating between ischemic and nonischemic priapism.

Priapism:
Group Application Exercise (GAE)

A 32-year-old male with a history of sickle cell disease presents to the emergency department with a painful erection lasting for more than four hours.

1. What type of priapism does the patient have?

2. Other than sickle cell disease, what are other possible risk factors for this condition?

3. You plan to initiate treatment, but would like to provide adequate analgesia to the patient. How do you perform a dorsal penile nerve block?

4. What treatment would you initiate? How do you perform it?

5. The intervention you performed in #4 is unsuccessful, so you call urology; what will they probably do?

6. As opposed to the above patient, a patient presents with a penile erection after direct trauma to the pelvis. What type of priapism is this and what is the treatment?

INSTRUCTOR MATERIALS

Answer keys to all exercises with explanations, are on the following pages.

Learners: Please do not proceed.

INSTRUCTOR MATERIALS

Priapism:
Readiness Assessment Test Key (RAT Key)

1. Match each term with the appropriate number:

_3_ Corpus Cavernosum

_2_ Corpus Spongiosum

_7_ Deep Dorsal Vein

_5_ Dorsal Artery

_6_ Dorsal Nerve

_1_ Urethra

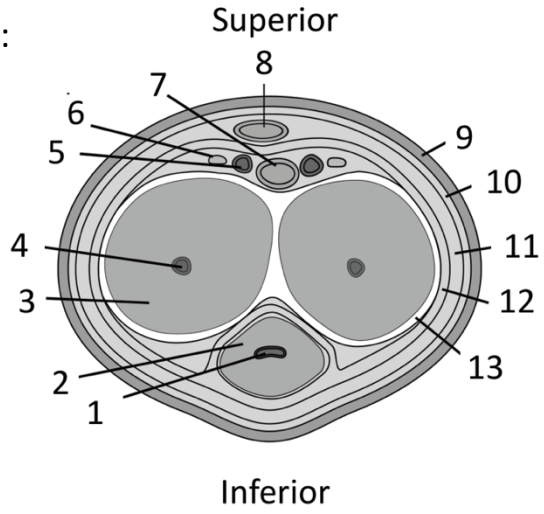

Image Source: Mcstrother. Cross section of penis with emphasis on fascial layers. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Penis_cross_section.svg. Published June 9, 2013. CC BY 3.0.

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Arterial | High flow | Intermittent | Ischemic
Low Flow | Nonischemic | Stuttering | Veno-occlusive

Type of Priapism	Synonym #1	Synonym #2	Definition
Ischemic	**Veno-Occlusive**	**Low Flow**	A urologic emergency characterized by a painful, persistent, fully rigid erection with little to no cavernous blood flow.
Non-Ischemic	**Arterial**	**High Flow**	Persistent erection caused by unregulated cavernous arterial inflow of blood often following trauma.
Stuttering	**Intermittent**		A recurrent form of ischemic priapism, where erections occur repeatedly.

3. Typically only the _____ is/are affected in priapism.
    a. **Corpora Cavernosa**
    b. Corpora Spongiosum

    Explanation: Only the corpora cavernosa is affected due to the persistent engorgement of the trabecular cavernosal tissue, reducing venous outflow.[1] The corpora spongiosum is not involved due to the relatively smaller volume it contains, and due to insignificant amount of venous outflow obstruction during engorgement. Refer to the image below to visualize the significant engorgement of the corpora cavernosum and venous outflow blockage.

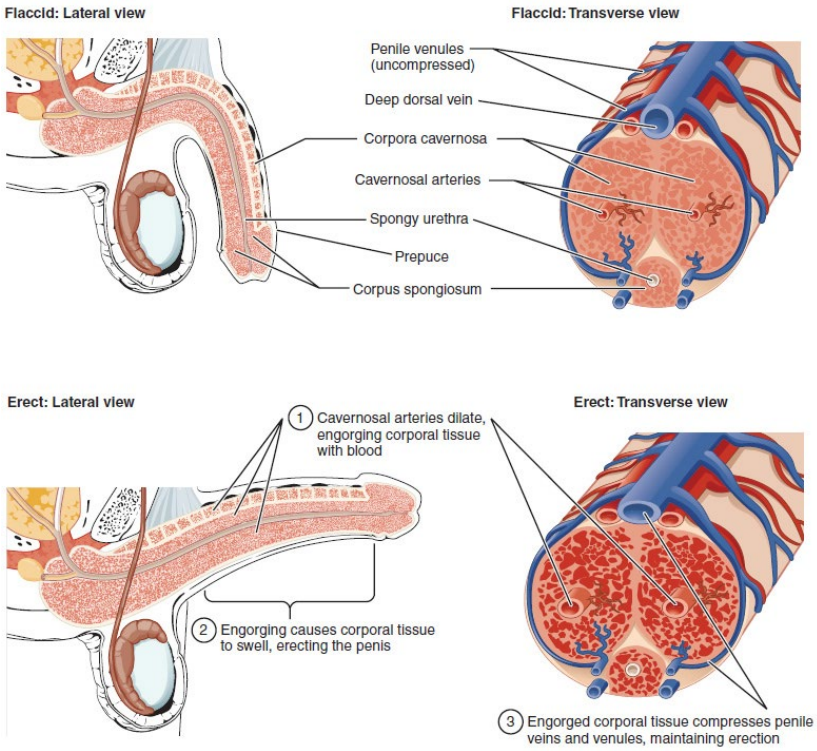

Image Source: OpenStax College. Three columns of erectile tissue make up most of the volume of the penis. In: Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Figure_28_01_06.jpg. CC BY 3.0.

4. If one were to perform a blood gas on the (answer to #3) in ischemic priapism, the blood gas would be:
    a. Similar to a normal arterial blood gas
    b. **Hypoxic, hypercarbic, and acidotic**
    c. Similar to a normal mixed venous blood gas

Explanation: Blood gas analysis on blood drawn from an ischemic priapism would show hypoxia, hypercarbia, and acidemia due to poor O_2 supply (low flow state) and reduced venous drainage resulting in decreased concentration of oxygenated blood (hypoxia), increased concentration of pCO_2 (hypercarbia and resultant acidemia).[1] See table 1 below.

5. If one were to perform a blood gas on the (answer to #3) in nonischemic priapism, the blood gas would be:
    a. **Similar to a normal arterial blood gas**
    b. Hypoxic, hypercarbic, and acidotic
    c. Similar to a normal mixed venous blood gas

Explanation: Blood gas analysis of a nonischemic priapism would be similar to a normal arterial blood gas because it is the result of an unregulated, high-flow state of engorgement, so the blood would be arterial in nature.[1] Furthermore, these patients tend to have better venous drainage due to the corpora cavernosum not being as engorged when compared to an ischemic priapism. This results in tissue still being well oxygenating and CO_2 waste products being removed in a timely manner, preventing the region from becoming acidotic and hypercarbic. Choice C would be the answer for a flaccid penis, and could be used to determine if a priapism has truly resolved.[1]
See table 1 below.

Source of Blood Gas[1]	Po_2 (mmHg)	Pco_2 (mmHg)	pH
Ischemic	<30	>60	<7.25
Non-ischemic (similar to normal arterial)	>90	<40	~7.40
Flaccid penis (similar to normal mixed venous)	~40	~50	~7.35

Table 1. Typical Blood Gas Values within varying scenarios[1]

Ultrasound may also be helpful in differentiating between ischemic and nonischemic priapism.

INSTRUCTOR MATERIALS

Priapism:
Group Application Exercise (GAE) Key

A 32-year-old male with a history of sickle cell disease presents to the emergency department with a painful erection lasting for more than four hours.

1. **What type of priapism does the patient have?**

   This is most likely ischemic due to past medical history pertinent for sickle cell disease (SCD). Priapism is an uncommon pathological condition with an incidence of 1.5 per 100,000 people per year among general population.[2] However, the prevalence of priapism dramatically increases for SCD patients, having priapism occurring in 3.6% of adolescent SCD patients and 42% of adult patients.[2] Despite having multiple types, SCD patients most commonly experience ischemic priapism due to the sickling nature of their red blood cells, resulting in vaso-occlusive states. In addition to vaso-occlusive states, SCD patients tend to have less concentration of intravascular nitrous oxide (NO), a potent vasodilator, due to increased concentration of free hemoglobin (Hb) caused by intravascular hemolysis.[2] Free Hb sequesters NO well as compared to poor sequestration when Hb is within red blood cells.[2] Some studies have also indicated that risk of priapism could be anticipated with increasing levels of lactate dehydrogenase, bilirubin, and reticulocyte count which can help predict the level of hypoxia and concentration of free Hb.

2. **Other than sickle cell disease, what are other possible risk factors for this condition?**

   - Idiopathic (most common).[2]
   - Iatrogenic (penile injection therapies for erectile dysfunction, eg, papaverine, trimix).[1]
   - Alpha-agonist medications (antipsychotics, antidepressants, antihypertensives, hydralazine, prazosin).[1]
   - Hematologic disorders (glucose-6-phosphate dehydrogenase deficiency, spherocytosis, S-beta-thalassemia, acute/chronic granulocytic leukemia, and multiple myeloma).[1]
   - Illicit drugs (cocaine).[2]

- Erectile dysfunction medications (phosphodiesterase type 5 [PDE5] inhibitors, eg, sildenafil).[1]
- Metastatic malignancy (penile or prostate malignancies).[1]
- Anticoagulants.[1]
- Metabolic disorders (Fabry's disease or amyloidosis).[1]

3. You plan to initiate treatment, but would like to provide adequate analgesia to the patient. How do you perform a dorsal penile nerve block?

Dorsal nerve penile block:[3]

1. By using anesthetic without epinephrine, construct skin wheals at the 2 and 10 0'clock positions at the base of the shaft with a 27-gauge needle.
2. Insert that same needle into center of skin wheal, navigating the needle towards the center of the penis.
3. Continue inserting until ~0.5cm depth, or until resistance is no longer felt. The needle should now be within Buck fascia.
4. Check location with aspiration, and once confirmation that needle isn't within a vein, inject ~2mL of local anesthetic.
5. Repeat steps 2-4 for other skin wheal.

Note: Ultrasound-guided dorsal nerve penile blocks have been increasing in popularity, but when compared to the traditional landmark technique, have not shown reduction in pain scores and increases time of block administration. As a result, the traditional landmark technique continues to be the gold standard.[4]

4. What treatment would you initiate? How do you perform it?

First-line treatment of ischemic priapism for episodes less than 24hrs (standard of care for ischemic priapism with 80% chance of resolution):[5]

1. Aspirate and irrigate the corpora cavernosa.
2. Inject sympathomimetic into corpora cavernosa. (See "Phenylephrine injection procedural steps" below).

    2a. Phenylephrine is the alpha-agonist of choice for injection to minimize cardiovascular side effects. Phenylephrine 100-500ug/ml can be administered every 3-5 minutes over 1 hour if needed before determining treatment failure.

INSTRUCTOR MATERIALS

First-line treatment of ischemic priapism for episodes greater than 24hrs:[2]

1. Trial above steps, but unlikely to resolve due to extended duration.
2. Consult urology for possible shunt (percutaneous distal shunt, open distal shunt, open proximal shunt, or vein anastomoses).

First-line treatment of ischemic priapism for episodes greater than 72hrs:[2]

1. Placement of penile prosthesis. Immediate placement is advantageous due to resolution of priapism, avoidance of shunting complications, prevention of penile shortening, and correction of penile fibrosis and inevitable erectile dysfunction.

Phenylephrine injection procedural steps:[5]

1. Insert a 16- or 18-gauge wide bore butterfly into the corpus cavernosum via the glans or lateral aspect of the proximal penile shaft.
2. Aspiration and irrigation occur simultaneously. Aspirate stagnant blood (darker color) and irrigate with sterile normal saline, and continue until new blood (bright red) is drawn.
3. Prepare a sympathomimetic or alpha-adrenergic agonist. Phenylephrine is the preferred agonist, and is to be diluted in normal saline to a concentration of 100-500µg/mL.
4. Inject 100-500µg of phenylephrine directly into the corpus cavernosum every 3-5 minutes. Do not administer more than 1mg/hr. Dosage for pediatric patients or patients with severe cardiovascular disease should be modified accordingly.
5. Monitor the patients' blood pressure and pulse every 15min for 1hr after injection with phenylephrine due to cardiovascular side effects.

One can consider diagnostic testing if the type of priapism is unclear: blood gas testing or ultrasound with Doppler evaluation. Diagnostic assessment of either type of priapism can help to identify main cause to prevent recurrence. It would also be appropriate to initiate treatment for sickle cell disease as long as it doesn't delay priapism treatment.

Diagnostic Evaluation:[2]

1. A complete blood count (CBC) with differential may be useful in determining the etiology of ischemia, whether it be due to hematologic abnormalities or malignancies such as leukemia. Consider sickle cell workup if there is no obvious etiology.

2. A urine toxicology and psychoactive medication screening may assess for pharmaceutical causes of priapism.

5. **The steps you take in #3 and #4 are unsuccessful, so you call urology; what will they probably do?**

   They will bring the patient to the operating room and create a cavernoglanular (corporoglandular) shunt. There are four main subtypes: percutaneous distal shunt, open distal shunt, open proximal shunt, or vein anastomoses.[2] There is not enough data to recommend one shunting technique over another, but erectile dysfunction rates increase with the proximity of shunt.[2]

6. **As opposed to the above patient, a patient presents with a penile erection after direct trauma to the pelvis. What type of priapism is this and what is the treatment?**

   Trauma-induced priapism is most likely nonischemic in nature, but penile blood gas analysis or ultrasound could be used to confirm diagnosis. Nonischemic priapism is a non-emergency and does not require immediate invasive treatment.[1] Patients should have a cold compress on affected penis, and be observed for spontaneous resolution which occurs in up to 62% of reported cases[1]. Aspiration, irrigation, and injection of sympathomimetics or alpha-adrenergic agonists are contraindicated due to high rates of spontaneous resolution and complication profile.[1]

Brief Wrap Up (optional): See attached PowerPoint for GAE answers and wrap-up discussion.