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AMERICAN UROLOGICAL ASSOCIATION GUIDELINE ON THE MANAGEMENT OF PRIAPISM

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INTRODUCTION

Priapism, a relatively uncommon disorder, is a medical emergency. Although not all forms of priapism require immediate intervention, ischemic priapism is associated with progressive fibrosis of the cavernosal tissues and erectile dysfunction.[1,2] Thus, all patients with priapism should be evaluated immediately in order to intervene as early as possible in those patients with ischemic priapism. The goal of the management of all patients with priapism is to achieve detumescence and preserve erectile function. Unfortunately, some of the treatments aimed at correcting priapism have the potential complication of erectile dysfunction. Therefore, the currently employed treatment modalities for priapism represent a range of options. These options are applied in a step-wise pattern with increasing invasiveness and risk balanced against the likelihood of prolonged ischemia and permanent damage to the corpora cavernosa if treatment is absent or delayed.

Because priapism is rare and usually unpredictable, the literature related to its management is neither voluminous nor rigorous, comprising mostly case reports and small case series rather than controlled trials. As a result, the relative efficacy and safety of different treatments are not clear. The purpose of this guideline is to provide physicians with a consensus of principles and strategies for the management of priapism based on the current state of both clinical practice and the medical literature.

Significant advances in the study of erectile physiology during the 1980s and 1990s have led to a better understanding of the pathophysiology of priapism and its management. For instance, prior to the discovery of pharmacological stimulation of an erection with vasodilators and the subsequent development of tests for penile blood flow, there was little awareness of the difference between ischemic and nonischemic priapism and the role of vasoconstrictor agents (alpha-adrenergic sympathomimetics) in the treatment of these disorders. Much of the literature on the management of priapism was published in an era in which the management of patients with priapism was largely empirical and sometimes misguided due to a lack of understanding of erectile physiology. However, even in the absence of effective treatment, it was recognized that, given enough time, ischemic priapism would eventually resolve on its own albeit with possible permanent damage to the penis. The literature reviewed for this guideline straddles both empirical and pathophysiology-based eras, and some of the reported positive responses to treatment may reflect the natural course of priapism rather than a true treatment success. In addition, the literature is bereft of followup data on patients with priapism.

This document derives from a comprehensive review of the medical literature related to the management of priapism. As noted, deficiencies in this literature made it impossible to develop strict evidence-based guidelines. Most of the recommendations contained herein are based upon expert consensus following review of the literature. Where possible, expert consensus is supplemented with review of limited data. Because the literature review only considered reports of cases in which the duration of erections were longer than 4 hours, the recommendations made may not apply to erections of shorter duration.

This guideline does not establish a fixed set of rules or define the legal standard of care for the treatment of priapism. Above all, it does not preempt physician judgment in individual cases. Variations in patient subpopulations, physician experience and available resources will necessarily influence choice of clinical strategy. Adherence to the recommendations presented in this document cannot assure a successful treatment outcome. The basis of each recommendation, consensus of the expert panel with or without data obtained by systematic review of evidence, is noted. A diagnostic and treatment algorithm is presented in the figure.

DEFINITIONS

Priapism is a persistent penile erection that continues hours beyond, or is unrelated to, sexual stimulation. Typically, only the corpora cavernosa are affected. For the purposes of this guideline, the definition is restricted to only erections of greater than 4 hours in duration. Priapism requires prompt evaluation and may require emergency management. Subtypes of priapism include:

- Ischemic (veno-occlusive, low flow) priapism is a nonsexual, persistent erection characterized by little or no cavernous blood flow and abnormal cavernous blood gases (hypoxic, hypercarbic and acidotic). The corpora cavernosa are rigid and tender to palpation. Patients typically report pain. A variety of etiologic factors may contribute to failure of the detumescence mechanism in this condition. Ischemic priapism is an emergency. Resolution of ischemic priapism is characterized by the penis returning to a flaccid, nonpainful state. However, in many cases persistent penile edema, ecchymosis and partial erections can occur and it may mimic unresolved priapism. Resolution of priapism can be verified by measurement of cavernous blood gases or blood flow measurement by color duplex ultrasonography.
- Nonischemic (arterial, high flow) priapism is a nonsexual, persistent erection caused by unregulated cavernous arterial inflow. Cavernous blood gases are not hypoxic or acidotic. Typically the penis is neither fully

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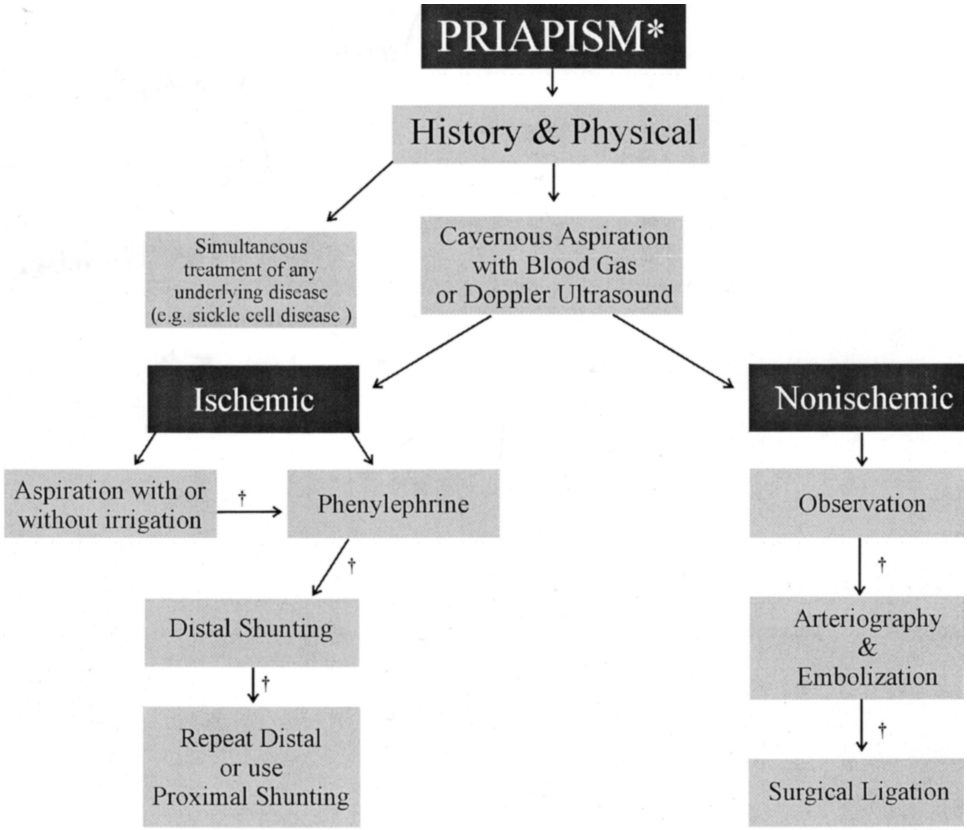

*Erection greater than 4 hours duration.
†Proceed upon treatment failure.

Management algorithm for priapism

rigid nor painful. Antecedent trauma is the most commonly described etiology. Nonischemic priapism does not require emergency treatment. Resolution of nonischemic priapism is characterized by a return to a completely flaccid penis.

- Stuttering (intermittent) priapism is a recurrent form of ischemic priapism in which unwanted painful erections occur repeatedly with intervening periods of detumescence. This historical term identifies a patient whose pattern of recurrent ischemic priapism encourages the clinician to seek options for prevention of future episodes.

METHODS

The Erectile Dysfunction Guideline Update Panel of the American Urological Association (AUA) was convened in April 2000 at the request of the AUA Board of Directors. The Practice Guidelines Committee of the AUA selected the Erectile Dysfunction Guideline Update Panel Co-Chairmen. The full panel roster was assembled by invitation to experts in the field.

Literature searches were performed using the MEDLINE database. All searches were restricted to articles written in English and published between 1966 and January 2001, which reported data from human subjects. The search was performed using a group of MeSH headings related to erectile dysfunction. An initial extraction process reviewed the articles and characterized their content in order to retrieve the subset of articles concerning priapism (Appendix 1, www.auanet.org). Additional relevant articles (eg publications prior to 1966) were added at the recommendation of individual panel members. More detailed data extraction was performed on the articles dealing with priapism (Appendix 2, www.auanet.org). Of the 217 articles reviewed (Appendix 3, www.auanet.org) 195 were ultimately considered acceptable. Reasons for rejecting articles during this stage included inadequate description of methods or definitions, lack of relevant data or coverage of the same data set in a later publication.

Due to the nature of the disease and the status of the literature, a meta-analysis was deemed inappropriate for this topic. Instead, a series of clinically important and potentially answerable questions was developed (Appendix 4, www.auanet.org) and the data extracted from the articles were organized to answer these questions. The evidence tables developed from this process focused on 3 primary outcomes: resolution of the priapism (flaccid penis for at least 24 hours), recurrence of priapism (after 24 hours of flaccidity) and erectile dysfunction. Additional tables detailing side effects were developed for some treatments. These results were then summed to provide crude estimates of treatment effects. The evidence tables were originally arranged to match the questions but have been reordered by patient characteristics and treatment (Appendix 5, www.auanet.org). A summary of the results was similarly reordered (Appendix 6, www.auanet.org). Unless otherwise noted, the statistics cited in this document are derived from the evidence tables.

Recommendations were developed either strictly by consensus or by consensus combined with review of the available, limited data. Following review and approval by the entire panel, the draft guideline was submitted for peer review to 64 urologists and other health care professionals. The

panel made revisions based on peer review comments and the document was submitted to and approved by the Practice Guidelines Committee and the Board of Directors of the AUA.

EVALUATION OF THE PRIAPISM PATIENT

The diagnosis of priapism is self-evident in the untreated patient. The evaluation of priapism should focus on differentiating ischemic from nonischemic priapism (table 1). Once this differentiation is made, the appropriate management can be determined and initiated. Evaluation of the patient with priapism has 3 components: patient history, physical examination and laboratory/radiological assessment.

Recommendation 1: In order to initiate appropriate management, the physician must determine whether the priapism is ischemic or nonischemic (based on panel consensus).

History. Understanding the history of the episode of priapism is important because the history and etiology may determine the most effective treatment. Historical features that should be identified are:

- Duration of erection
- Degree of pain (ischemic priapism is painful while nonischemic priapism usually is not)
- Previous history of priapism and its treatment
- Use of drugs that might have precipitated the episode. Drugs that have been associated with priapism are antihypertensives; anticoagulants; antidepressants and other psychoactive drugs; alcohol, marijuana, cocaine and other illegal substances; and vasoactive agents used for intracavernous injection therapy such as alprostadil, papaverine, prostaglandin E_1, phentolamine and others
- History of pelvic, genital or perineal trauma, especially a perineal straddle injury
- History of sickle cell disease or other hematologic abnormality

Examination. The genitalia, perineum and abdomen should be carefully examined. In patients with priapism the corpora cavernosa are affected while the corpus spongiosum and the glans penis are not. In patients with ischemic priapism the corpora cavernosa are often completely rigid. In patients with nonischemic priapism the corpora are typically tumescent but may not be completely rigid (table 1). Abdominal, pelvic and perineal examination may reveal evidence of trauma or malignancy.

Laboratory and radiological evaluation. The laboratory evaluation of patients with priapism should include a complete blood count (CBC) with special attention to the white blood count, white blood cell differential and platelet count. Acute infections or hematologic abnormalities that can cause priapism, such as sickled red blood cells, leukemia and platelet abnormalities, may be suggested or identified by the CBC.

The reticulocyte count is often elevated in men with sickle cell anemia. Hemoglobin electrophoresis identifies the presence of sickle cell disease or trait as well as other hemoglobinopathies. Because hemoglobinopathies are not confined to black men but may be found in white men, especially of Mediterranean descent (eg thalassemia), a reticulocyte count and hemoglobin electrophoresis should be considered in all men unless there is another obvious cause of priapism. However, in an emergency setting hemoglobin analysis may not yield results in a timely fashion. In such cases screening for sickle cell disease or trait should be performed by either the Sickledex test or examination of a peripheral smear, preferably with consultation by a hematologist and subsequent confirmation using hemoglobin electrophoresis.

Screening for psychoactive drugs and urine toxicology may be performed (if suspected) because standard doses of antidepressants and other psychoactive drugs, as well as overdoses of legal and illegal drugs, may cause priapism.

Blood gas testing and color duplex ultrasonography are currently the most reliable diagnostic methods of distinguishing ischemic from nonischemic priapism (table 1). Blood aspirated from the corpus cavernosum in patients with ischemic priapism is hypoxic and therefore dark, while blood from the corpus cavernosum in patients with nonischemic priapism is normally oxygenated and therefore bright red. Cavernosal blood gases in men with ischemic priapism typically have a P_{O_2} of less than 30 mm Hg, P_{CO_2} of greater than 60 mm Hg and pH less than 7.25. Cavernous blood gases in men with nonischemic priapism are similar to the blood gases of arterial blood. Normal flaccid penis cavernous blood gas levels are approximately equal to those in normal mixed venous blood. Typical blood gas values are shown in table 2.

Color duplex ultrasonography may be used as an alternative to cavernosal blood gas sampling to differentiate ischemic from nonischemic priapism. Patients with ischemic priapism have little or no blood flow in the cavernosal arteries, while patients with nonischemic priapism have normal to high blood flow velocities in the cavernosal arteries. Ultrasonography will reveal the absence of any significant blood flow within the corpora cavernosa. It may also be performed as a screening test for anatomical abnormalities, such as a cavernous artery fistula or pseudoaneurysm, in men who already have the diagnosis of nonischemic priapism. These abnormalities are most often due to a straddle injury or direct scrotal trauma and, therefore, are most often found in the perineal portions of the corpora cavernosa. Color duplex ultrasonography should be performed in the lithotomy or frogleg position, scanning the perineum first and then along the entire shaft of the penis.

Penile arteriography may be used as an adjunctive study to identify the presence and site of a cavernous artery fistula (ruptured helicine artery). Since color duplex ultrasonography has largely supplanted arteriography for the diagnosis of cavernous artery fistulas, arteriography is usually only performed as part of an embolization procedure. In summary, the laboratory and radiological tests that should be considered in the diagnostic evaluation of priapism are CBC, reticulocyte count, hemoglobin electrophoresis, psychoactive medication screening, urine toxicology, blood gas testing, color duplex ultrasonography and penile arteriography.

TABLE 1. *Key findings in the evaluation of priapism*

Finding	Ischemic Priapism	Nonischemic Priapism
Corpora cavernosa fully rigid	Usually present	Seldom present
Penile pain	Usually present	Seldom present
Abnormal cavernous blood gases	Usually present	Seldom present
Blood abnormalities and hematologic malignancy	Sometimes present	Seldom present
Recent intracavernous vasoactive drug injections	Sometimes present	Seldom present
Chronic, well-tolerated tumescence without full rigidity	Seldom present	Usually present
Perineal trauma	Seldom present	Sometimes present

ISCHEMIC PRIAPISM

Ischemic priapism is an acute problem with increasing potential for injury over time. Although the etiology of the

TABLE 2. *Typical blood gas values*

Source	P_{O_2} (mm Hg)	P_{CO_2} (mm Hg)	pH
Ischemic priapism (cavernous blood)[3]	Less than 30	Greater than 60	Less than 7.25
Normal arterial blood (room air)	Greater than 90	Less than 40	7.40
Normal mixed venous blood (room air)	40	50	7.35

ischemic priapism may be an important factor to the future management of the patient (to prevent subsequent episodes), it is rarely relevant to the initial management of the ischemic priapism. Because the response to treatment is not always predictable, the panel's recommendations comprise a stepwise approach beginning with intracavernous injection of an alpha-adrenergic sympathomimetic agent, with or without evacuation of old blood, and followed, when necessary, by a surgical shunting procedure.

Recommendation 2: In patients with an underlying disorder, such as sickle cell disease or hematologic malignancy, systemic treatment of the underlying disorder should not be undertaken as the only treatment for ischemic priapism. The ischemic priapism requires intracavernous treatment, and this should be administered concurrently (based on panel consensus).

Ischemic priapism is a compartmental syndrome and thus requires intracavernous treatment. In patients with an underlying disorder, such as sickle cell disease or hematologic pathology, intracavernous treatment of the ischemic priapism should be provided concurrently with appropriate systemic treatment for the underlying disease. Ischemic priapism resolved in 0% to 37% of patients with sickle cell disease managed only with systemic treatments (transfusion, alkalization, hydration, oxygen) while much better resolution rates were achieved with therapies directed at the penis. There are few published reports on patients with hematologic disorders other than sickle cell disease. Of 4 cases with hematologic malignancies treated with pheresis procedures 3 experienced resolution of the priapism but only 3 of 15 treated with other chemotherapies resolved. Moreover, many of the "treatment successes" with systemic therapy occurred after prolonged periods of ischemia and may represent the end result of the natural history of ischemic priapism rather than a true treatment-related resolution. Even without treatment, all priapism will resolve but erectile function may be compromised. Review of the published cases of ischemic priapism managed with systemic treatments alone revealed that 7 of 20 (35%) had erectile dysfunction. Thus, while systemic treatments may ultimately prove to be effective, the current data suggest that any delay in the direct treatment (ie intracavernous treatment) of the penis is not justified.

Recommendation 3: Management of ischemic priapism should progress in a step-wise fashion to achieve resolution as promptly as possible. Initial intervention may utilize therapeutic aspiration (with or without irrigation) or intracavernous injection of sympathomimetics (based on panel consensus and review of limited data).

Recommendation 4: If ischemic priapism persists following aspiration/irrigation, intracavernous injection of sympathomimetic drugs should be performed. Repeated sympathomimetic injections should be performed prior to initiating surgical intervention (based on panel consensus and review of limited data).

Vasoactive properties of sympathomimetic drugs confer on these agents the potential to relieve priapism by facilitating detumescence mechanisms. Review of the literature reveals significantly higher resolution of priapism following sympathomimetic injection with or without irrigation (43% to 81%) than aspiration with or without irrigation alone (24% to 36%). The risk of post-priapism erectile dysfunction also appears to be lower when sympathomimetic agents are used.

Therapeutic aspiration is often the first maneuver employed following insertion of a scalp vein (19 or 21 gauge) needle into the corpus cavernosum for diagnostic purposes. This procedure lowers intracorporal pressure thus facilitating subsequent intracavernous injections. Priapism resolved in 36% of patients with ischemic priapism treated with aspiration alone. Other studies have shown resolution of priapism in 24% of patients treated with aspiration plus irrigation. Due to the limitations of the literature, the panel believes that this difference is not real and the efficacy of aspiration with or without irrigation is approximately 30%. The physician should be prepared to continue treatment with administration of a sympathomimetic agent if therapeutic aspiration, with or without irrigation, fails to relieve priapism.

The value of aspiration as an adjunct to sympathomimetic injection is unclear from the literature reviewed. Summary data indicated a 58% resolution rate with no recurrences following sympathomimetic injection without prior aspiration or irrigation. A 77% resolution rate was achieved by sympathomimetic injection in patients who had undergone prior aspiration or irrigation, however recurrence was reported in 6 of 16 patients. It is possible that some of these recurrences were in fact initial failures according to the panel definition (posttreatment flaccidity lasting less than 24 hours). Thus, the apparent improved resolution rates with sympathomimetic injection after aspiration, with or without irrigation, are questionable.

Recommendation 5: For intracavernous injection of a sympathomimetic agent, the panel recommends use of phenylephrine because this agent minimizes the risk of cardiovascular side effects that are more common for other sympathomimetic medications (based on panel consensus and review of limited data).

The sympathomimetic drugs include epinephrine, norepinephrine, phenylephrine, ephedrine and metaraminol. There are no published direct efficacy comparisons of these agents. The summary data developed by the panel showed that for all patients with ischemic priapism resolution occurred in 81% treated with epinephrine, 70% with metaraminol, 43% with norepinephrine and 65% with phenylephrine. Posttreatment erectile function was generally not reported in published studies but among those in which it was reported, erectile dysfunction was found in only 1 patient after treatment with sympathomimetic injection. Many sympathomimetic agents (eg epinephrine) are direct activators of both alpha and beta-adrenergic receptors. Indirect actions of these drugs often include stimulation of endogenous norepinephrine release with subsequent mixed alpha and beta effects.[4] Significant cardiovascular side effects of sympathomimetics released into the systemic circulation derive from actions on both the peripheral vasculature (alpha-mediated hypertensive effects) and the heart (beta-mediated inotropic and chronotropic effects). The therapeutic efficacy of these agents for priapism relies on alpha receptor-mediated vasoconstriction within the corpora cavernosa. Phenylephrine is an $alpha_1$-selective adrenergic agonist with no indirect neurotransmitter-releasing action. Thus, it has the therapeutic action desired for treating priapism while minimizing other potential adverse effects.

Recommendation 6: For intracavernous injections in adult patients, phenylephrine should be diluted with normal saline to a concentration of 100 to 500 μg/ml and 1 ml injections made every 3 to 5 minutes for approximately 1 hour, before deciding that the treatment will not be successful. Lower concentrations in smaller volumes should be used in children and patients with severe cardiovascular disease (based on panel consensus).

Recommendation 7: During and following intracavernous injection of sympathomimetic drugs, the physician should observe patients for subjective symptoms and objective findings consistent with known undesirable effects of these agents: acute hypertension, headache, reflex bradycardia, tachycardia, palpitations and cardiac arrhythmia. In patients with high cardiovascular risk, blood pressure and electrocardiogram monitoring is recommended (based on panel consensus).

Recommendation 8: The use of surgical shunts for the treatment of ischemic priapism should be considered only

after a trial of intracavernous injection of sympathomimetics has failed (based on panel consensus).

A surgical shunt[5,6] should not be considered as first line therapy. The decision to initiate surgery requires the failure of nonsurgical interventions. However, deciding when to end nonsurgical procedures and proceed with surgery will depend on the duration of the priapism. For ischemic priapism of extended duration, response to intracavernous injections of sympathomimetics becomes increasingly unlikely. Phenylephrine is less effective in priapism of more than 48 hours in duration because ischemia and acidosis impair the intracavernous smooth muscle response to sympathomimetics.[3] Under such anoxic conditions, phenylephrine produces poorly sustained phasic contractile responses. In particular, injection of sympathomimetics after 72 hours offers a lower chance of successful resolution and a surgical shunting procedure often is required to re-establish circulation of the corpora cavernosa.

Recommendation 9: A cavernoglanular (corporoglanular) shunt should be the first choice of the shunting procedures because it is the easiest to perform and has the fewest complications. This shunting procedure can be performed with a large biopsy needle (Winter) or a scalpel (Ebbehøj) inserted percutaneously through the glans. It can also be performed by excising a piece of the tunica albuginea at the tip of the corpus cavernosum (Al-Ghorab). Proximal shunting using the Quackels or Grayhack procedures may be warranted if more distal shunting procedures have failed to relieve the priapism (based on panel consensus and review of limited data).

Of the 3 methods of the cavernoglanular (distal) shunt, excision of both tips of the corpora cavernosa (Al-Ghorab) is the most effective and can be performed even if the other 2 procedures fail. In most cases shunts will close with time. However, long-term patency of the shunt may lead to erectile dysfunction.[7] Shunting procedures evaluated during analysis of evidence included distal shunts (eg Winter, Ebbehøj and Al-Ghorab procedures), cavernospongious (corporospongiosal) shunt (ie Quackels procedure) and cavernosaphenous (corporosaphenous) shunt (ie Grayhack procedure). The limited data preclude a recommendation of a greater efficacy for one procedure over another based on accurate outcome estimates. The summary data generated by the panel indicate resolution rates of 74% for Al-Ghorab, 73% for Ebbehøj, 66% for Winter, 77% for Quackels and 76% for Grayhack procedures. Erectile dysfunction rates are higher for the proximal shunts (Quackels and Grayhack, about 50%) than for the distal shunts (25% or less). However, patient selection and time to treatment may be the main explanations for these differences. Each surgical shunting procedure may have its own constellation of adverse events. Assessing the literature was difficult due to the fact that patients frequently received multiple treatments and, therefore, it was not easy to ascertain the treatment that produced an adverse event.

A distal shunting procedure is generally successful in re-establishing penile circulation in cases other than those with severe distal penile edema or tissue damage. In these cases more proximal shunting procedures may be considered, and a shunt can be created between the corpus cavernosum and corpus spongiosum (Quackels). Alternatively, a proximal shunt such as between the corpus cavernosum and saphenous vein (Grayhack) is performed. These procedures are time-consuming and technically challenging. Reports of serious adverse events include urethral fistulas and purulent cavernositis following the Quackels shunt[8] and pulmonary embolism following the Grayhack procedure.[9]

Recommendation 10: Oral systemic therapy is not indicated for the treatment of ischemic priapism (based on panel consensus and review of limited data).

The literature contains no data supporting the use of oral sympathomimetic treatment for ischemic priapism. Although not priapism, prolonged erections due to injection therapy may show some response to oral terbutaline treatment. Two randomized controlled trials examined the use of oral terbutaline in patients with prolonged erections of less than 4 hours in duration following pharmacologic stimulation of an erection. Despite the lack of statistical significance, meta-analysis showed a trend suggestive of possible benefit. A summary of uncontrolled trials indicated a 65% resolution rate. Despite infrequent use by urologists and evidence from only 2 randomized controlled trials, terbutaline may be effective in the treatment of prolonged erections due to self-injection therapy for impotence.[10] There is no evidence for the efficacy of oral pseudoephedrine in the treatment of either prolonged erections or priapism.

NONISCHEMIC PRIAPISM

Nonischemic (high flow) priapism is an uncommon form of priapism caused by unregulated arterial inflow. This condition may follow perineal trauma that results in laceration of the cavernous artery. However, many patients have no apparent underlying cause. Panel summary data indicated spontaneous resolution to be the outcome of untreated nonischemic priapism in up to 62% of the reported cases with an associated complaint of erectile difficulties in a third. Rare cases of a high flow state occurring after resolution of ischemic priapism have been reported[11] but the cause is not understood. Possible mechanisms include the mechanical disruption of arteriolar or sinusoidal anatomy[12] and dysregulation of vasorelaxing/vasoconstrictive factors resulting from ischemic damage.[13]

Recommendation 11: In the management of nonischemic priapism corporal aspiration has only a diagnostic role. Aspiration with or without injection of sympathomimetic agents is not recommended as treatment (based on panel consensus and review of limited data).

Although aspiration is used in the diagnosis of nonischemic priapism, aspiration with or without injection of vasoconstrictive agents has no demonstrated therapeutic efficacy. In the data reviewed by the panel, there were no cases of priapism resolution after aspiration or irrigation. In the patient with nonischemic priapism administration of sympathomimetic agents may be expected to have significant adverse systemic effects given the pathophysiology of unregulated arterial inflow and large venous outflow that are characteristic of this condition. Injection of methylene blue, an inhibitor of guanylate cyclase, may have some efficacy.[14] However, the limited outcomes data on treatment of nonischemic priapism with methylene blue preclude any panel recommendation concerning this approach.

Recommendation 12: The initial management of nonischemic priapism should be observation. Immediate invasive interventions (embolization or surgery) can be performed at the request of the patient, but should be preceded by a thorough discussion of chances for spontaneous resolution, risks of treatment-related erectile dysfunction and lack of significant consequences expected from delaying interventions (based on panel consensus and review of limited data).

Nonischemic priapism is not an emergency and will often resolve without treatment. Acute conservative treatment, such as ice and site-specific compression to the injury, may be used. However, there are insufficient data to conclude that conservative measures offer any additional benefit beyond the spontaneous resolution rate. Several published case series are quite remarkable for showing that time from trauma to patient presentation, ranging from days to years, has no significant impact on subsequent outcome, and that many patients remain potent after spontaneous resolution of priapism.

Recommendation 13: Selective arterial embolization is recommended for the management of nonischemic priapism in

patients who request treatment. Autologous clot and absorbable gels, which are non-permanent, are preferable to coils and chemicals, which are permanent, in the interventional radiological management of nonischemic priapism (based on panel consensus and review of limited data).

Although the data are not robust enough to determine the effects of using permanent materials, the panel's experience suggests that nonabsorbable materials used during embolization pose a greater risk for erectile dysfunction and other complications than absorbable materials. Several series have documented the efficacy of absorbable materials such as autologous blood clot and gelatin sponges in nonpermanent embolization. Permanent embolization techniques involve the use of coils, ethanol, polyvinyl alcohol particles and acrylic glue. The reviewed literature indicated resolution of high flow priapism in 78% of cases treated with permanent embolization technologies and an associated erectile dysfunction rate of 39%. In contrast, temporary embolization technologies had a 74% resolution rate and 5% associated erectile dysfunction rate. There are few published surgical series in the management of high flow priapism and no controlled trials of observation, embolization or surgery. Penile exploration and direct surgical ligation of sinusoidal fistulas/pseudoaneurysms are efficacious in up to 63% of cases with an associated erectile dysfunction rate of 50%. Surgical management of nonischemic priapism is the option of last resort for long-standing cases in which a cystic mass with a thick wall can be visualized with intraoperative color duplex ultrasonography. In the patients who receive these treatments other therapies have usually failed and the erectile dysfunction rate may reflect this selection bias.

Recommendation 14: Surgical management of nonischemic priapism is the option of last resort and should be performed with intraoperative color duplex ultrasonography (based on panel consensus and review of limited data).

A number of radiological technologies have been described for the diagnosis and management of nonischemic priapism: selective pudendal arteriography, nuclear imaging, cavernosography, computerized tomography and color duplex ultrasonography. Color duplex ultrasonography is the least invasive of the technologies employed in various studies and may be used to document spontaneous resolution or persistence of a high flow state. This technique can reveal arterial dilatation, increased cavernous arterial flow and a sinusoidal "blush" or pseudoaneurysm cavity with turbulent flows. Using color duplex ultrasonography, the lesion is lateralized and localized, thus providing essential information prior to radiological embolization or surgical intervention.

STUTTERING PRIAPISM

Patients with ischemic priapism may have a pattern of recurrence over time which is distinct from persistence or rapid recurrence of a single episode of priapism. This pattern of recurrence, known as stuttering priapism, challenges the clinician to develop a management strategy to prevent future episodes of priapism. Each episode of ischemic priapism in these patients should be managed as described in prior sections of this guideline. While the etiology of recurrent ischemic priapism is often idiopathic, patients with hematologic abnormalities, such as sickle cell disease, are more prone to recurrent (stuttering) priapism.

Recommendation 15: The goal of the management of a patient with recurrent (stuttering) priapism is prevention of future episodes while management of each episode should follow the specific treatment recommendations for ischemic priapism (based on panel consensus).

There have been several reports in the literature of stuttering priapism in children and adults.[15,16] Each episode of priapism in these patients is distinct with multiple episodes over time. Hematologic abnormalities are commonly present in children with this disorder but the condition is often idiopathic in adults. Once the priapism has recurred, representing a failure of the prevention strategy, the case should be managed as an emergency as described previously.

Management strategies for patients with stuttering priapism have historically included prevention of priapism episodes with systemic therapies, early intervention by the patient with self-injection of sympathomimetic agents, and, as a last resort, surgical placement of a penile prosthesis. Systemic therapies proposed for the prevention of priapism have included hormonal agents,[15,17–20] baclofen,[21] digoxin[22] and terbutaline.[23] Although terbutaline has been shown to be effective in the management of prolonged erections, there is little evidence to support its use in this clinical setting. Digoxin has no proven efficacy in the treatment of priapism. Recently, 2 cases of stuttering priapism have been successfully treated with oral baclofen.

Recommendation 16: A trial of gonadotropin-releasing hormone (GnRH) agonists or antiandrogens may be used in the management of patients with recurrent (stuttering) priapism. Hormonal agents should not be used in patients who have not achieved full sexual maturation and adult stature (based on panel consensus).

Hormonal therapy for stuttering priapism has been aimed at suppressing serum testosterone levels by feedback inhibition (diethylstilbestrol), blocking androgen receptors (antiandrogens) and down-regulation of the pituitary gland (GnRH agonists). There is minimal information regarding the efficacy and safety of most of these agents, and none has been investigated using controlled study designs. Hormonal agents, specifically GnRH agonists, appear to be effective and while they reduce libido, most patients are still able to engage in sexual activity.[17–20] The use of diethylstilbestrol has more risks including gynecomastia and embolic events.

Hormonal agents have a contraceptive effect and interfere with normal sexual maturation. In addition, they may interfere with the timing of the closure of the epiphyseal plates. Therefore, these agents are contraindicated in persons (children) who have not completed their growth and sexual maturation and those trying to conceive.

Recommendation 17: Intracavernosal self-injection of phenylephrine should be considered in patients who either fail or reject systemic treatment of stuttering priapism (based on panel consensus).

Several studies have shown that early management at home by the patient with intracavernosal injection of sympathomimetics can be an effective strategy to avoid hospitalization for recurrent priapism.[16,20,24,25] This method of management is not preferred over systemic therapies because priapism in such cases is being treated rather than prevented, and the potential exists for adverse effects of inadvertent systemic administration of sympathomimetics. Patients who cannot be treated with hormonal therapy may be taught self-injection therapy of sympathomimetics. Patients should be counseled regarding injection site, dosing, systemic side effects and duration of erection prior to performing self-injection with sympathomimetic agents.

CONCLUSIONS

Clearly, despite the low incidence of priapism and the considerable challenge of providing successful treatment, clinical urology continues to address this potentially emergent condition. While still deficient in many respects, our understanding of the pathophysiology, diagnosis and management of priapism has been advanced by many significant basic and clinical investigative efforts. The published results of clinical studies on priapism have, in particular, made the present document possible.

The review of the clinical literature on priapism has answered some questions and raised new ones. The Panel has

made specific recommendations when the weight of consensus and available data was sufficient to support confidence in a particular approach and it has noted when evidence was absent, incomplete or ambiguous. Certain details of assessment and treatment of priapism are not uniformly reported in the literature. This information is needed to adequately evaluate outcomes, improve practice guidelines and continue the progress to date in the management of priapism.

Recommendations for Future Research: Clinical studies of priapism should be designed to consider and ultimately report on the following:

- Documentation of pre-priapism erectile function by retrospective report from the patient and, when possible, also from the partner
- Time from onset of priapism to initial treatment and time to each subsequent treatment
- Measurement of sexual function after resolution of priapism
  - Using a standardized instrument for 1 year
  - Using contemporary validated instruments for assessing quality of life
  - Reporting erection potential as determined by a minimum of subjective reporting within 3 months of *and* up to 1 year after priapism diagnosis and, when not normal, the results of continued evaluation for up to 1 year
- Additional treatments used to regain erectile function (based on panel consensus).

REFERENCES

1. El-Bahnasawy, M. S., Dawood, A. and Farouk, A.: Low-flow priapism: risk factors for erectile dysfunction. BJU Int, **89:** 285, 2002
2. Spycher, M. A. and Hauri, D.: The ultrastructure of erectile tissue in priapism. J Urol, **135:** 142, 1986
3. Broderick, G. A. and Harkaway, R.: Pharmacologic erection: time-dependent changes in the corporal environment. Int J Impot Res, **6:** 9, 1994
4. Hoffman, B.: Catecholamines, sympathomimetic drugs, and adrenergic receptor antagonists. In: Goodman and Gilman's The Pharmacological Basis of Therapeutics. Edited by J. G. Hardman, L. E. Limbird and A. G. Gilman. New York: McGraw-Hill Professional Publishing, chapt. 10, pp. 215–268, 2001
5. Nitahara, K. S. and Lue, T. F.: Priapism. In: Glenn's Urologic Surgery. Edited by S. D. Graham, Jr., J. F. Glenn and C. C. Carson. Philadelphia: Lippincott Williams & Wilkins, 1998
6. Hinman, F., Jr., Donley, S. and Stempen, P. H.: Atlas of Urologic Surgery, 2nd ed. Philadelphia: W. B. Saunders Co., sect. 6, pp. 177–228, 1998
7. Kulmala, R. V., Lehtonen, T. A., Lindholm, T. S. and Tammela, T. L.: Permanent open shunt as a reason for impotence or reduced potency after surgical treatment of priapism in 26 patients. Int J Impot Res, **7:** 175, 1995
8. Ochoa Urdangarain, O. and Hermida Perez, J. A.: Priapism. Our experience. Arch Esp Urol, **51:** 269, 1998
9. Kandel, G. L., Bender, L. I. and Grove, J. S.: Pulmonary embolism: a complication of corpus-saphenous shunt for priapism. J Urol, **99:** 196, 1968
10. Lowe, F. C. and Jarow, J. P.: Placebo-controlled study of oral terbutaline and pseudoephedrine in management of prostaglandin E1-induced prolonged erections. Urology, **42:** 51, 1993
11. Seftel, A. D., Haas, C. A., Brown, S. L., Herbener, T. E., Sands, M. and Lipuma, J.: High flow priapism complicating veno-occlusive priapism: pathophysiology of recurrent idiopathic priapism? J Urol, **159:** 1300, 1998
12. Matson, S., Herndon, C. D. A. and Honig, S. C.: Pathophysiology of "low flow" priapism: intermediate phase-evidence of "high flow" defined with duplex ultrasound. Int J Impot Res, **11:** S27, 1999
13. Bastuba, M. D., Saenz de Tejada, I., Dinlenc, C. Z., Sarazen, A., Krane, R. J. and Goldstein, I.: Arterial priapism: diagnosis, treatment and long-term followup. J Urol, **151:** 1231, 1994
14. Steers, W. D. and Selby, J. B., Jr.: Use of methylene blue and selective embolization of the pudendal artery for high flow priapism refractory to medical and surgical treatments. J Urol, **146:** 1361, 1991
15. Gbadoe, A. D., Assimadi, J. K. and Segbena, Y. A.: Short period of administration of diethylstilbestrol in stuttering priapism in sickle cell anemia. Am J Hematol, **69:** 297, 2002
16. Virag, R., Bachir, D., Lee, K. and Galacteros, F.: Preventive treatment of priapism in sickle cell disease with oral and self-administered intracavernous injection of etilefrine. Urology, **47:** 777, 1996
17. Dahm, P., Rao, D. S. and Donatucci, C. F.: Antiandrogens in the treatment of priapism. Urology, **59:** 138, 2002
18. Levine, L. A. and Guss, S. P.: Gonadotropin-releasing hormone analogues in the treatment of sickle cell anemia-associated priapism. J Urol, **150:** 475, 1993
19. Serjeant, G. R., de Ceulaer, K. and Maude, G. H.: Stilboestrol and stuttering priapism in homozygous sickle-cell disease. Lancet, **2:** 1274, 1985
20. Steinberg, J. and Eyre, R. C.: Management of recurrent priapism with epinephrine self-injection and gonadotropin-releasing hormone analogue. J Urol, **153:** 152, 1995
21. Rourke, K. F., Fischler, A. H. and Jordan, G. H.: Treatment of recurrent idiopathic priapism. J Urol, **168:** 2552, 2002
22. Gupta, S., Salimpour, P., Saenz de Tejada, I., Daley, J., Gholami, S., Daller, M. et al: A possible mechanism for alteration of human erectile function by digoxin: inhibition of corpus cavernosum sodium/potassium adenosine triphosphatase activity. J Urol, **159:** 1529, 1998
23. Ahmed, I. and Shaikh, N. A.: Treatment of intermittent idiopathic priapism with oral terbutaline. Br J Urol, **80:** 341, 1997
24. Gbadoe, A. D., Atakouma, Y., Kusiaku, K. and Assimadi, J. K.: Management of sickle cell priapism with etilefrine. Arch Dis Child, **85:** 52, 2001
25. Van Driel, M. F., Joosten, E. A. and Mensink, H. J.: Intracorporeal self-injection with epinephrine as treatment for idiopathic recurrent priapism. Eur Urol, **17:** 95, 1990