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# REVIEW: Selective Imaging in Suspected Penile Fracture: A Narrative Review of Ultrasound, MRI, and Evaluation of Associated Urethral Injury

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**ABSTRACT**

Penile fracture is a time-sensitive urologic emergency caused by rupture of the tunica albuginea of one or both corpora cavernosa, most often after abrupt bending of the erect penis. In a classic presentation, the combination of a characteristic mechanism, a cracking or snapping sensation, immediate detumescence, pain, swelling, and ecchymosis is usually sufficient for diagnosis, and routine imaging should not delay surgical repair. Imaging is most useful when the presentation is atypical, a false penile fracture is plausible, or preoperative localization may change the surgical approach. High-frequency ultrasound is the preferred first-line examination in equivocal cases because it is rapid, accessible, inexpensive, and capable of demonstrating focal tunical discontinuity and adjacent hematoma. Because its sensitivity is operator- and location-dependent, a negative or nondiagnostic ultrasound does not reliably exclude a small or proximal tear when clinical suspicion persists. MRI provides superior soft-tissue contrast and more precise tear mapping and is best reserved as a problem-solving examination for discordant, proximal, complex, or otherwise uncertain injuries. Associated urethral injury should be evaluated selectively rather than routinely. Blood at the urethral meatus, gross hematuria, voiding difficulty or retention, and bilateral corporal injury should prompt retrograde urethrography and/or flexible cystoscopy. A selective escalation pathway preserves rapid treatment for obvious fractures while reducing unnecessary imaging and avoidable exploration in mimics.

## Introduction

Penile fracture is the traumatic rupture of the tunica albuginea surrounding the corpus cavernosum, usually after forceful bending of an erect penis and an abrupt rise in intracavernosal pressure. Although uncommon, it is a urologic emergency because delayed or missed repair can be followed by penile curvature, painful erection, palpable fibrosis, erectile dysfunction, and urethral complications (1-8). The vulnerability of the erect penis is partly anatomic: the tunica albuginea is a dense fibroelastic envelope whose thickness and mechanical properties vary across the shaft, and erection markedly reduces its effective thickness while increasing internal pressure (9).

The diagnosis is often clinical. A typical patient reports a cracking or snapping sound, sudden pain, immediate detumescence, and rapid swelling or

ecchymosis. This characteristic mechanism and examination have historically been sufficient to justify exploration in most cases, and contemporary AUA and EAU guidance continues to treat penile fracture primarily as a clinical diagnosis requiring prompt surgical management when findings are convincing (1,4,10-15).

The practical controversy is therefore not whether imaging can detect a tunical tear, but when imaging adds information that changes management. Routine imaging in an obvious fracture can delay definitive repair, whereas avoiding imaging in every case can lead to negative exploration when dorsal venous injury, isolated hematoma, or soft-tissue contusion mimics fracture. Modern high-frequency ultrasound and MRI can clarify tunical integrity, localize the defect, characterize hematoma, and identify alternative diagnoses; urethral studies answer the separate question of whether an associated urethral injury is present (16-18,20-23).

This narrative review focuses on a selective imaging strategy for suspected penile fracture, emphasizing the complementary roles of ultrasound and MRI, the recognition of false penile fracture, and targeted evaluation of associated urethral injury. The central clinical principle is to preserve immediate treatment for classic fractures while using imaging only when it resolves genuine diagnostic or operative uncertainty.

## Literature Search

Relevant literature for this narrative review was identified through PubMed/MEDLINE and Google Scholar. The AUA Urotrauma Guideline and EAU Guidelines on Urological Trauma were also consulted. The literature search was updated through September 12, 2026.

## 6.1. Anatomy and Pathophysiology of Penile Fracture

### Tunica albuginea structure

The tunica albuginea is a collagen-rich, bilaminar fibroelastic envelope surrounding each corpus cavernosum. Its structure is not mechanically uniform along the shaft; cadaveric work demonstrates regional differences in thickness and tensile strength, with relative vulnerability on the ventral aspect (9). During erection, expansion of the corpora stretches and thins the tunica, reducing the margin of safety against sudden buckling forces.

### Mechanism of rupture

Fracture occurs when an erect penis is abruptly bent beyond the tensile capacity of the tunica. The resulting spike in intracavernosal pressure produces a transverse or oblique rent, commonly in the proximal or mid shaft. Mechanisms vary by population: sexual intercourse is common in Western cohorts, whereas intentional forceful bending of the erect penis, including taqaandan, has been prominent in some Middle Eastern series (10,19). Mechanism is clinically relevant because the energy and direction of injury may influence tear complexity and the probability of associated urethral disruption.

### Clinical consequences

Once the tunica ruptures, cavernosal blood dissects into surrounding tissues, producing rapidly expanding hematoma, swelling, deformity, and ecchymosis. The extent of bruising depends in part on whether Buck fascia remains intact. A tear extending toward the corpus spongiosum can coexist with urethral injury. Failure to recognize a true fracture or delay in repair may increase the risk of fibrosis, curvature, painful erections, erectile dysfunction, and urinary complications (1-8).

## 6.2. Clinical Diagnosis and Rationale for Selective Imaging

### Classic presentation

The classic syndrome consists of trauma to the erect penis followed by an audible or palpable snap, immediate pain and detumescence, and rapid penile swelling with ecchymosis. A palpable tunical defect and deviation away from the injured side may be present. When the history and examination are concordant, pre-test probability is high enough that additional imaging usually adds little to the decision to explore (1,4,10-15).

### When imaging adds value

Imaging is most useful when one or more elements of the classic syndrome are absent or discordant. Examples include incomplete or delayed detumescence, localized rather than diffuse swelling, no palpable defect, suspected proximal injury near the penile base, uncertainty about whether the hematoma is superficial or cavernosal, and clinical concern for a vascular mimic. Imaging may also be valuable when accurate tear localization would permit a targeted incision rather than broad exposure (20-23).

### When to proceed directly to surgery

A convincing mechanism together with immediate detumescence and characteristic swelling or deformity should prompt urgent urologic exploration and repair without waiting for confirmatory imaging. Imaging should not become a mandatory gatekeeper in a textbook fracture, and a technically limited or equivocal study should not delay surgery when clinical probability remains high (14,15,20,23).

### False penile fracture and mimics

Dorsal vein rupture, injury to other penile vessels, isolated hematoma, and soft-tissue contusion may closely mimic fracture. These injuries can produce pain, swelling, and ecchymosis but often lack the complete sequence of snap, immediate detumescence, and a definite cavernosal defect. This is the main setting in which selective imaging may prevent unnecessary exploration while still protecting patients with occult tunical injury (22,35).

## 6.3. Ultrasound

### Technique and Characteristic Findings

High-frequency linear-array ultrasound is the most accessible cross-sectional technique for acute penile trauma. A careful examination should include transverse and longitudinal sweeps from the distal shaft to the base, with focused assessment of the side of maximal swelling or tenderness. The proximal shaft deserves deliberate attention because deep tears can be missed. Color Doppler is useful when a vascular lesion or active bleeding is suspected. The normal tunica appears as a thin echogenic line around the corpora cavernosa (24-28).

The most specific sonographic finding is focal discontinuity of the tunica albuginea with adjacent hematoma. Secondary findings include heterogeneous cavernosal echotexture, intracavernosal or extratunical hematoma, contour deformity, and, less consistently, corpus spongiosum abnormalities. Visualization of intact tunica at the site of swelling can support an alternative diagnosis, particularly when the hematoma is superficial (24-28,41).

### Diagnostic Performance and Tear Mapping

Diagnostic performance varies according to operator experience, equipment, tear location, hematoma burden, and the reference standard. In the 2022 cohort reported by Spiesecke et al., ultrasound sensitivity was 71.4% and specificity was 100%, whereas MRI sensitivity and specificity were 91.9% and 90.6%, respectively (20). The practical implication is asymmetrical: a clearly demonstrated tunical defect is highly persuasive, but a negative study does not universally exclude fracture when clinical suspicion remains substantial.

Preoperative mapping may be better when examinations are performed by experienced radiologists. Zare Mehrjardi et al. reported

fracture detection rates of 88% for ultrasound and 100% for MRI in 25 consecutive patients, with more accurate mapping by MRI (21). In the 2024 cohort by von Stempel et al., ultrasound correctly confirmed and marked the fracture site in 92% of fracture cases, while imaging also identified a high proportion of alternative diagnoses (22). When localization is reliable, skin marking can support a limited surgical approach; however, imaging may underestimate the full operative length of the tunical defect (22).

### Strengths and Limitations

Ultrasound is rapid, inexpensive, radiation-free, repeatable, and frequently available at the bedside. These characteristics make it the preferred first-line imaging study when a fracture is not clinically secure (15,21,24-28). Point-of-care ultrasound can shorten the diagnostic pathway in emergency settings, but the published evidence is largely case-based and should not be interpreted as equivalent to a validated radiology-performed protocol (28,41).

Its limitations are important: the examination is operator dependent, and edema, pain, large hematoma, small defects, deep proximal tears, and incomplete visualization can obscure a rupture. Consequently, the report should indicate whether the tunica was adequately visualized along the full shaft. If the examination is negative or nondiagnostic but the clinical concern persists, MRI or surgical exploration is preferable to simple reassurance (20,21,23).

## 6.4. Magnetic Resonance Imaging (MRI)

### Imaging Appearance and Technical Advantages

MRI offers the highest soft-tissue contrast among commonly used modalities for suspected penile fracture. The tunica albuginea is seen as a low-signal-intensity rim around the corpora, and rupture appears as focal interruption of this rim, usually with adjacent hematoma. Multiplanar high-resolution T2-weighted sequences are particularly useful for defining tear location, side, length, and relationship to the corpus spongiosum, while T1-weighted imaging helps characterize blood products. Intravenous contrast is not routinely required for demonstrating an acute tunical defect (29-34).

MRI is less affected than ultrasound by acoustic access and can remain informative in severe swelling or complex hematoma. Early work by Fedel et al. demonstrated its value in clinically atypical cases, and subsequent surgical-correlation studies confirmed strong agreement between MRI localization and operative findings (29-34).

### Diagnostic Accuracy and Clinical Role

Saglam et al. reported MRI sensitivity of 100%, specificity of 87.5%, and a negative predictive value of 100% in a controlled study of 38 surgically correlated patients (32). In the 2022 comparative cohort, MRI sensitivity and specificity were 91.9% and 90.6% (20). MRI also outperformed ultrasound for precise preoperative mapping in the prospective 2017 study by Zare Mehrjardi et al. (21). More recent retrospective evidence supports MRI as a problem-solving test when ultrasound is negative or discordant with ongoing clinical suspicion (22,23).

The appropriate role of MRI is selective rather than routine. It is most useful after a negative or nondiagnostic ultrasound when suspicion persists, in proximal or complex injuries, when examination and ultrasound disagree, and when precise mapping is expected to change the operative approach. In a classic high-probability fracture, MRI should not delay definitive exploration (14,15).

### Strengths and Limitations

The principal strengths of MRI are superior soft-tissue contrast, multiplanar tear mapping, reduced operator dependence, and improved characterization of associated hematoma or mimics. The major constraints are access, cost, scan duration, patient tolerance, and potential delay within emergency workflows. These limitations are especially relevant where MRI

cannot be obtained promptly outside routine hours. MRI therefore functions best as an escalation test rather than a universal prerequisite for surgery.

**Table 2.** Representative studies informing selective imaging

| Study (author, year) | Design / sample | Principal result | Implication |
|---|---|---|---|
| **Fedel et al., 1996 (30)** | Clinically equivocal cases; MRI compared with sonography/cavernosography | MRI identified cavernosal rupture in all 4 atypical cases studied with the three modalities. | Supports MRI when clinical findings are atypical or other tests are inconclusive. |
| **Zare Mehrjardi et al., 2017 (21)** | Prospective; 25 patients; US and MRI before surgery | Detection rate: US 88%, MRI 100%; precise mapping favored MRI (97% vs 81% of mapped items). | US is practical first-line imaging; MRI improves mapping when greater precision is needed. |
| **Saglam et al., 2017 (32)** | Controlled study; 38 surgically correlated patients | MRI sensitivity 100%, specificity 87.5%, NPV 100%. | High-quality MRI is a strong problem-solving study in selected equivocal cases. |
| **Spiesecke et al., 2022 (20)** | Retrospective; 88 patients; 69 MRI and 31 US examinations | MRI sensitivity/specificity 91.9%/90.6%; US 71.4%/100%. | Positive US is persuasive; negative US should not override persistent clinical suspicion. |
| **von Stempel et al., 2024 (22)** | Retrospective; 193 suspected fractures | 54% had alternative diagnoses; US correctly confirmed and marked the fracture site in 92% of fracture cases; MRI often showed more extensive injury. | Selective imaging can identify mimics and support focused operative planning. |
| **Morische et al., 2026 (23)** | Retrospective single-center; 16 patients | US and MRI correlated in most cases, but false-negative and false-positive US findings occurred. | Supports MRI after negative/uncertain US when suspicion persists. |
| **Ahmadnia et al., 2014 (18)** | Retrospective; 116 penile fractures; RUG in all patients | Only 4 (3%) had urethral injury, and all had gross hematuria and urethrorrhagia. | Routine RUG is low yield in the absence of urethral warning signs. |

## 6.5. Other Imaging Modalities

### Cavernosography: Historical Role and Current Status

Cavernosography was historically used to confirm corporal rupture by injecting contrast into the corpora and demonstrating extravasation. It can directly demonstrate a leak, but the test is invasive, uncomfortable, uses ionizing radiation and contrast, can be technically limited, and does not provide the soft-tissue characterization available with ultrasound or MRI. With contemporary cross-sectional imaging and the continued primacy of clinical diagnosis, cavernosography has largely moved from routine evaluation to a historical or exceptional problem-solving role (16,17).

### CT and Point-of-Care Ultrasound

CT is not an established routine modality for penile fracture. Published support consists largely of limited reports rather than robust diagnostic-accuracy cohorts. A 2019 case report showed that CT could localize an incomplete tunical tear and assist minimally invasive operative planning, but this level of evidence is insufficient to position CT ahead of ultrasound or MRI in standard algorithms (42). CT may be encountered when broader pelvic trauma is being assessed or when other modalities are unavailable, but radiation exposure and limited validation restrict its routine use.

Point-of-care ultrasound (POCUS) is conceptually an implementation of the same sonographic principles used in formal ultrasound. Emergency-physician-performed ultrasound has been reported both to demonstrate tunical rupture and to show intact tunica in a clinically suspicious superficial hematoma (28,41). Its potential advantage is speed at the bedside; its principal limitation is that diagnostic reliability is tightly linked to operator expertise and completeness of scanning. POCUS should therefore accelerate, not replace, urologic decision-making when the examination remains uncertain.

**Table 1.** Practical comparison of diagnostic modalities in suspected penile fracture

| Modality | Best use | Key positive findings | Main strengths | Main limitations | Selective role |
|---|---|---|---|---|---|
| **High-frequency ultrasound** | First-line imaging in equivocal cases; tear localization | Focal tunical discontinuity; adjacent hematoma; cavernosal contour change | Rapid, accessible, low cost, no radiation, dynamic | Operator dependent; small/proximal tears and hematoma may obscure defect | Use first when imaging is needed; escalate if negative/nondiagnostic and suspicion persists (20,21,24-28). |
| **MRI** | Problem-solving after uncertain ultrasound; precise mapping; mimics | Low-signal tunical discontinuity on multiplanar images; hematoma; spongiosal extension | Highest soft-tissue contrast; less operator dependent; excellent mapping | Cost, availability, longer examination, potential delay | Reserve for persistent diagnostic uncertainty or complex/proximal injury (20-23,29-34). |
| **Retrograde urethrography (RUG)** | Suspected associated urethral injury | Contrast extravasation, discontinuity, or luminal irregularity | Direct assessment of urethral integrity; established test | Invasive; radiation/contrast; can delay surgery; technical false negatives possible | Use selectively with blood at meatus, gross hematuria, voiding symptoms, retention, bilateral injury, or other strong suspicion (14,15,18). |
| **Flexible cystoscopy** | Urethral assessment when surgery is planned | Directly visualized mucosal disruption or partial/complete tear | Real-time direct visualization; can be intraoperative | Requires equipment, expertise, and procedural setting | Alternative or complement to RUG when urethral injury is suspected (14,15). |
| **Cavernosography** | Historical or exceptional problem-solving role | Contrast extravasation from corpus cavernosum | Can demonstrate corporal leak | Invasive, painful, radiation/contrast, largely superseded | Not favored routinely where ultrasound/MRI are available (16,17). |

## 6.6. False Penile Fracture and Alternative Diagnoses

### Dorsal vein rupture

Rupture of the superficial or deep dorsal penile vein can produce abrupt swelling and ecchymosis after intercourse and can be clinically difficult to distinguish from tunical rupture. The absence of a definite tunical defect on high-quality imaging, together with visualization of a vascular abnormality or superficial hematoma, can support a vascular mimic. Color Doppler may be particularly useful when venous injury is suspected (22,24-27,35).

### Isolated hematoma

An isolated cavernosal, subcutaneous, or foreskin hematoma may reproduce the dramatic appearance of fracture without true tunical discontinuity. In the 2024 cohort of 193 patients with suspected fracture, 54% ultimately had an alternative diagnosis, illustrating how frequently imaging may encounter non-fracture causes in selected patients referred for imaging (22).

### Soft tissue contusion

Blunt trauma to a flaccid or incompletely erect penis can cause soft-tissue edema and contusion without the characteristic immediate detumescence of a true fracture. The clinical context remains central: imaging should be interpreted alongside the mechanism, the timing of detumescence, and the distribution of swelling rather than in isolation.

### Role of imaging in avoiding unnecessary exploration

The principal value of imaging in false penile fracture is not to override a classic fracture diagnosis but to clarify uncertain cases in which unnecessary exploration is plausible. El-Assmy et al. reported that MRI demonstrated intact tunicae in clinically atypical patients managed conservatively, whereas ultrasound produced false-positive findings in some surgically explored patients (35). The best use of imaging is therefore selective: confirm a convincing tunical defect when uncertainty exists, identify a defensible alternative diagnosis when the tunica is intact, and escalate to MRI or exploration when

ultrasound and clinical probability remain discordant.

## 6.7. Associated Urethral Injury

### Incidence and Clinical Predictors

Reported rates of associated urethral injury vary substantially with mechanism, geography, referral patterns, case definition, and how aggressively the urethra is evaluated. The EAU guideline cites urethral involvement in approximately 10-22% of penile fractures, whereas a 2023 systematic review of case series identified 65 urethral injuries among 1,665 penile-fracture patients, a point prevalence of 3.9%; a US inpatient analysis reported a substantially higher coded rate (15,36,37). These estimates are not directly interchangeable and should not be treated as a single universal incidence.

The most important bedside warning signs are blood at the urethral meatus, gross hematuria, urethrorrhagia, dysuria, difficulty voiding, and urinary retention. Bilateral corporal injury is a recognized additional risk factor and should lower the threshold for dedicated urethral assessment (14,15,36-40). The absence of warning signs lowers probability but does not absolutely exclude an occult urethral tear.

### Retrograde Urethrography: Routine or Selective?

RUG directly evaluates urethral continuity and can demonstrate contrast extravasation, luminal irregularity, or complete disruption. The question in penile fracture is whether it should be performed routinely. In the 10-year series by Ahmadnia et al., 116 men underwent preoperative RUG; urethral injury was identified in only four patients (3%), and all four had macroscopic hematuria and urethrorrhagia (18). The study is retrospective and single-center, so it cannot eliminate occult injury, but it strongly supports symptom- and sign-directed testing rather than universal RUG.

This approach is consistent with guideline principles. The AUA recommends urethral evaluation in penile fracture when blood at the meatus, gross hematuria, or inability to void is present and identifies bilateral corporal fracture as an additional risk factor; options include RUG or urethroscopy (14). The EAU similarly recognizes RUG and/or flexible cystourethroscopy for suspected male urethral injury (15).

### Flexible Cystoscopy

Flexible cystoscopy provides direct visualization of the urethral lumen and can be performed immediately before or during penile exploration. It is particularly efficient when surgery is already indicated because corporal and urethral assessment can occur under the same anesthetic. The choice between RUG and cystoscopy depends on local workflow, equipment, urologic expertise, and whether the patient is already proceeding to the operating room; available guidance does not establish one as universally superior (14,15).

### Can Ultrasound or MRI Replace Dedicated Urethral Evaluation?

Neither penile ultrasound nor MRI should be considered a complete substitute for RUG or cystoscopy when urethral injury is clinically suspected. Ultrasound may show corpus spongiosum disruption or periurethral hematoma, and MRI may depict associated spongiosal or periurethral abnormality, but the evidence is insufficient to validate either as a stand-alone urethral test (27,29,39). Penile imaging and dedicated urethral evaluation therefore answer related but distinct questions: ultrasound and MRI primarily define tunical integrity and tear location, whereas RUG and cystoscopy directly assess the urethra.

### 6.8. Proposed Selective Imaging Algorithm

The proposed pathway begins with clinical diagnosis. A classic presentation should proceed directly to urgent exploration and repair without routine confirmatory imaging. When the presentation is equivocal, high-frequency ultrasound is the first-line test. A clearly positive ultrasound can confirm the tear and assist

operative localization. If ultrasound is negative or nondiagnostic but clinical suspicion persists, MRI is the preferred problem-solving examination when it can be obtained without clinically important delay. MRI is particularly useful for proximal injuries, complex hematoma, discordant examinations, and suspected false fracture (14,15,20-23).

**Table 3.** Clinical predictors and indications for urethral evaluation in suspected penile fracture

| Clinical feature | Reported association / evidence | Recommended action |
|---|---|---|
| **Blood at the urethral meatus** | Strong clinical warning sign recognized in guideline-based urethral-trauma evaluation (14,15). | Perform dedicated urethral evaluation with RUG and/or flexible cystoscopy. |
| **Gross hematuria** | Associated with increased suspicion; present in reported urethral-injury cohorts and in all urethral injuries in the Ahmadnia series together with urethrorrhagia (18,36-39). | RUG and/or flexible cystoscopy; do not omit evaluation solely because corporal injury is already evident. |
| **Urethrorrhagia** | Direct sign of urethral bleeding; all four urethral injuries in Ahmadnia et al. had urethrorrhagia plus gross hematuria (18). | Dedicated urethral evaluation is indicated. |
| **Dysuria or voiding difficulty** | Commonly reported warning symptom in associated urethral injury (15,36-39). | Lower threshold for RUG/cystoscopy; evaluate before or during repair depending on workflow. |
| **Urinary retention / inability to void** | Guideline-recognized trigger for urethral evaluation (14,15). | Prompt RUG and/or cystoscopy; avoid blind urethral instrumentation if major disruption is suspected. |
| **Bilateral corporal injury** | Recognized risk factor; bilateral corporal fracture is associated with urethral injury in clinical series and AUA guidance (14,37,38). | Perform or strongly consider dedicated urethral assessment, including intraoperative cystoscopy if proceeding to surgery. |
| **Proximal or complex tear** | Complex injury can coexist with spongiosal/urethral extension, but evidence is less specific than for hematuria, meatal blood, retention, or bilateral injury (22,39). | Use clinical context; lower threshold for cystoscopy/RUG when complex tear coexists with urethral symptoms or bilateral injury. |
| **Absence of urethral warning signs** | Reduces pre-test probability; in the Ahmadnia series, no urethral injuries were found without gross hematuria/urethrorrhagia (18). | No routine RUG; continue clinical surveillance and inspect/evaluate selectively if operative findings raise concern. |

Assessment for urethral injury should occur in parallel rather than as a routine add-on. Blood at the meatus, gross hematuria, urethrorrhagia, voiding difficulty or retention, and bilateral corporal injury should trigger RUG and/or flexible cystoscopy. If the patient is already proceeding to surgery, intraoperative cystoscopy is often the most efficient option. In the absence of urethral warning signs, routine preoperative RUG is not supported by the available evidence (14,15,18,36-39).

## 6.9. Clinical Implications for Emergency Physicians, Radiologists, and Urologists

### What each specialty should know

Emergency physicians should recognize that a textbook penile fracture does not require imaging before urgent urologic consultation. Their key tasks are to identify the classic mechanism and detumescence pattern, document urethral warning signs, avoid delays caused by unnecessary testing, and use ultrasound selectively when the presentation is genuinely uncertain. When POCUS is used, a negative bedside study should not overrule a strongly suggestive history (14,15,28,41).

Radiologists should frame the examination around the clinical decision. The report should not stop at “fracture present” or “fracture absent.” When a defect is seen, it should describe side, shaft level, approximate clock-face or surface location when practical, estimated length, hematoma distribution, relationship to the corpus spongiosum, and any evidence of bilateral injury or a vascular/soft-tissue mimic. When no tear is identified, the report should state whether the tunica was completely visualized and note technical limitations that reduce confidence (20-23).

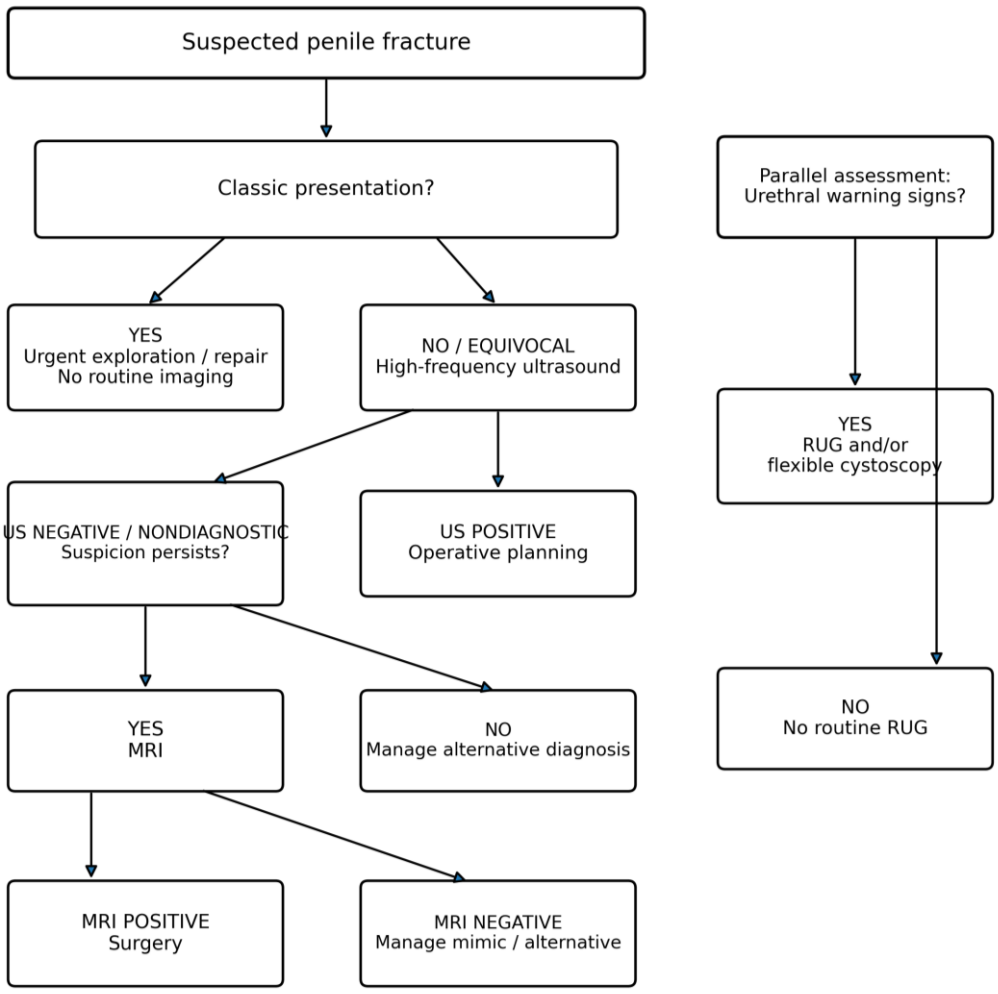


**Figure 1.** Proposed selective imaging and urethral-evaluation pathway for suspected penile fracture.

Clinical diagnosis remains the first step. Classic presentations proceed to urgent repair without routine imaging. Equivocal cases undergo high-frequency ultrasound, with MRI reserved for persistent uncertainty after a negative or nondiagnostic ultrasound. Urethral warning signs are assessed in parallel and prompt targeted RUG and/or flexible cystoscopy; in their absence, routine RUG is not recommended.

Urologists should integrate imaging with pre-test probability. A positive, well-localized ultrasound can support a focused incision, while MRI can resolve persistent uncertainty or better define complex proximal injury. Conversely, an equivocal or technically limited ultrasound should not delay exploration when the clinical diagnosis is compelling. Urethral evaluation should remain targeted to symptoms, signs, bilateral injury, or operative concern (14,15,18,21,22).

## Suggested reporting template for radiologists

A practical structured report can include: examination adequacy and modality; integrity of the right and left tunica albuginea; side and shaft level of any defect; approximate defect length and orientation; location and extent of hematoma; corpus spongiosum/periurethral findings; vascular abnormality if Doppler was performed; presence or absence of bilateral injury; alternative diagnosis when identified; and a concise impression stating whether findings confirm

fracture, are indeterminate, or support a mimic. If the study is limited, the reason should be explicit.

### Timing and workflow considerations

The diagnostic pathway should be organized to minimize time from recognition to definitive repair. Ultrasound has the greatest value when it is immediately available and performed by an experienced operator; MRI is appropriate only when it answers unresolved uncertainty without causing clinically important delay. Urethral testing can often be integrated into the operative pathway, particularly by flexible cystoscopy when surgery is already planned. The workflow goal is therefore selective escalation, not sequential testing of every modality.

## 7. Limitations

The evidence supporting imaging in penile fracture is limited by marked heterogeneity across studies. Populations differ in mechanism of injury, clinical pre-test probability, referral patterns, imaging protocols, operator experience, and the reference standard used to confirm fracture. Most available studies are retrospective and single-center, and randomized trials comparing diagnostic pathways are lacking. These design features make sensitivity and specificity estimates difficult to generalize directly across institutions.

Ultrasound is inherently operator dependent, and its performance varies with transducer frequency, completeness of scanning, tear location, hematoma burden, and examiner expertise. MRI is less operator dependent for image acquisition and offers superior mapping, but limited availability, cost, scan duration, and emergency workflow constraints restrict routine use. Studies of RUG are also limited; the frequently cited 116-patient series supporting selective RUG is retrospective and single-center (18), and occult urethral injury remains possible even in the absence of classic warning signs.

The literature also lacks robust cost-effectiveness analyses comparing immediate exploration, ultrasound-first, and MRI-escalation strategies. Data are insufficient to define the incremental value of CT, to establish the diagnostic performance of point-of-care ultrasound across operators, or to determine whether advanced penile imaging can safely replace dedicated urethral evaluation. These limitations support a pragmatic, probability-based approach rather than a rigid universal testing algorithm.

## 8. Conclusion

Penile fracture remains primarily a clinical diagnosis, and a classic presentation should proceed promptly to surgical repair without routine confirmatory imaging. In equivocal cases, high-frequency ultrasound is the preferred first-line examination; MRI should be reserved for negative or nondiagnostic ultrasound with persistent suspicion, complex or proximal injury, or unresolved concern for a mimic. Evaluation of the urethra should be selective rather than routine, using RUG and/or flexible cystoscopy when blood at the meatus, gross hematuria, urethrorrhagia, voiding difficulty or retention, bilateral corporal injury, or other operative findings raise suspicion.

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All authors meet the ICMJE authorship criteria.

## Conflicts of interest

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