

Case Study

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Filling-Associated Haematuria Following Bladder Injury and Suprapubic Catheter Drainage: A Case Narrative and Mechanistic Hypothesis

Bruce H. Knox*

Independent Scholar, Auckland, New Zealand

***Corresponding Author**

Bruce H. Knox, Independent Scholar, Auckland, New Zealand.

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Abstract

Background

Visible haematuria following bladder injury or repair raises concern for ongoing tissue injury, disruption of a repair, catheter-related trauma, infection, calculi, or another urinary tract source. An unusual clinical pattern may, however, provide additional mechanistic information: haematuria that becomes apparent as the bladder fills but rapidly diminishes when the bladder is continuously decompressed through a suprapubic catheter (SPC).

Case presentation

An adult patient recovering from a bladder injury requiring repair experienced recurrent episodes of macroscopically bloody urine in association with bladder filling. When the SPC was connected to a freely draining leg bag, the haematuria rapidly diminished and was replaced by increasingly clear, normally coloured urine. The relationship was sufficiently reproducible to suggest that bladder volume and/or pressure was influencing the bleeding phenomenon.

Interpretation

The observation generates a plausible biomechanical hypothesis. Bladder filling produces progressive wall distension and tissue strain. In a recently injured bladder, this may place mechanical stress on a healing site, granulation tissue, newly formed microvasculature, or catheter-contact region. Changes in bladder geometry during filling may additionally alter contact between the catheter tip or balloon and the mucosa, while detrusor contractions or catheter-related bladder spasms may generate transient additional forces. Continuous drainage reverses these conditions by maintaining relative bladder decompression, reducing wall tension and intravesical pressure, limiting accumulation of blood within retained urine, and continuously washing residual blood from the lumen.

Conclusion

A reproducible sequence of bladder filling → visible haematuria → decompression → rapid clearing is physiologically coherent and may indicate mechanically influenced vesical bleeding. The phenomenon does not, however, identify the precise anatomical source and should not be interpreted as proof of uncomplicated healing. Persistent or recurrent gross haematuria after bladder injury warrants appropriate urological assessment to exclude repair failure, continued mucosal injury, infection, obstruction, calculi, or another urinary tract pathology.

Keywords: Bladder Injury, Bladder Repair, Haematuria, Suprapubic Catheter, Bladder Decompression, Bladder Filling, Wound Healing, Catheter Trauma, Bladder Spasm

1. Introduction

The urinary bladder is unusual among healing hollow organs because its wall is repeatedly subjected to large changes in geometry. During normal storage, the bladder progressively expands while maintaining relatively low intravesical pressure through its compliant viscoelastic wall and neuromuscular regulation. Bladder compliance is therefore not simply a passive property: it represents the relationship between increasing storage volume, wall distension and detrusor pressure [1–3]. Following bladder injury, these otherwise physiological changes acquire additional importance. Contemporary European Association of Urology guidance specifically states that continuous bladder drainage following bladder injury is required to prevent elevated intravesical pressure and permit bladder healing.¹ Similarly, trauma and surgical literature recognises bladder decompression as a central element of postoperative management [2–4]. This case highlights a clinically striking extension of that principle: visible haematuria repeatedly associated with bladder filling, followed by rapid clearing when an SPC was connected to continuous drainage. It explores whether these observations reflect two mechanical states of the same healing bladder rather than unrelated events.

2. Case Presentation

An adult patient sustained a bladder injury that required repair and subsequently required drainage through an SPC. During healing, a distinctive pattern of macroscopic haematuria emerged. When the bladder was permitted to accumulate urine, drainage could become visibly bloody, including episodes of bright-red urine. In contrast, when the SPC was connected to a freely draining leg bag and the bladder was continuously decompressed, the appearance changed comparatively rapidly:

red urine → pink or diluted urine → pale urine → apparently normal urine.

The speed of this transition was noteworthy: rather than remaining uniformly blood-stained, the urine returned to a visually normal colour relatively quickly after continuous drainage was established. The central clinical question therefore became:

Why should bladder filling be associated with bleeding when bladder decompression appears to make that bleeding subside?

This observation does not in itself identify where the bleeding originates. Nevertheless, its reproducibility suggests that bladder volume, wall tension, pressure, catheter position or detrusor activity may be contributing variables.

3. The Bladder as a Dynamic Mechanical Organ

The bladder is designed to accommodate considerable increases in volume. Compliance describes the change in volume relative to the change in detrusor pressure [5]. During normal filling, connective tissue, smooth muscle, urothelium, neural signalling and the overall geometry of the bladder interact to allow storage at relatively low pressure [5,6]. This does not mean, however, that filling occurs without mechanical consequences. Bladder-wall surface area increases substantially, individual layers undergo deformation, and local wall tension changes. Transient

spontaneous detrusor movements can also occur during the storage phase [6]. In an intact bladder these changes are physiological. In a recently repaired bladder, the same expansion may potentially affect healing tissue very differently.

4. Bladder Healing: Surface Repair Versus Mechanical Maturation

The bladder possesses considerable regenerative capacity. Urothelial re-epithelialisation can occur comparatively rapidly after injury. Reviews of bladder repair note experimental evidence of mucosal and serosal re-epithelialisation within several days [3]. The deeper wound, however, must also regain collagen organisation and mechanical strength. Classic experimental studies demonstrated substantial recovery of bladder-wall tensile strength over approximately three weeks, with collagen synthesis particularly active early in wound healing [7]. These experimental findings cannot provide an exact healing timetable for an individual human patient, but they demonstrate an important principle:

an apparently closed bladder surface is not necessarily biologically identical to fully matured, mechanically resilient bladder tissue.

A healing site also contains inflammatory cells, extracellular matrix and developing microvasculature. Such tissue may reasonably be more susceptible to mechanical irritation than mature bladder wall.

5. A Proposed Mechanism for Filling-Associated Bleeding

5.1. Increasing Bladder Volume Produces Tissue Strain

As urine accumulates, the bladder changes from a relatively collapsed structure into an increasingly distended reservoir.

This expansion stretches the bladder wall.

If a repair site remains mechanically vulnerable, progressive distension may impose repetitive traction across:

- the healing bladder wall,
- a suture or previous repair line,
- adjacent inflamed mucosa,
- granulation tissue, or
- fragile local microvasculature.

This does not require catastrophic failure of the repair. A very small superficial bleeding point could potentially produce strikingly coloured urine.

5.2. A Small Bleed may look much Greater in Retained Urine

If the SPC is closed, intermittently drained, or otherwise permitting bladder filling, a small amount of bleeding has time to accumulate within a finite volume of urine. The resulting drainage may therefore appear intensely red even when the absolute blood loss is relatively small. Once continuous drainage begins, further accumulation stops and newly produced urine entering through the ureters washes residual blood from the bladder. Consequently, the visual progression from red to pink to yellow can occur quite rapidly even though no instantaneous biological transformation has occurred. The colour of the urine therefore reflects both the **rate of bleeding and the time allowed for blood to accumulate and mix within the bladder.**

5.3. The Possible Contribution of the SPC

An indwelling catheter is not mechanically neutral.

Catheter-associated mucosal injury is increasingly recognised. A 2025 scoping review found bladder mucosal abnormalities in all eight included studies of indwelling urinary catheters, although the authors emphasised substantial limitations in the evidence base and heterogeneity between studies [8]. Catheter-related bladder discomfort and detrusor spasms are also well-described [9]. An SPC may therefore contribute to intermittent bleeding through several possible mechanisms. As the bladder fills, its geometry changes around the relatively fixed catheter tract. This may change the relationship between the catheter tip, balloon and bladder wall. A surface that does not contact the catheter when the bladder is relatively empty could potentially contact it during another phase of filling, or vice versa. Catheter traction may also transmit force to the internal cystostomy site. In addition, irritation by a catheter can provoke bladder spasms.⁹ A detrusor contraction produces a short-lived increase in pressure and movement of the bladder wall, potentially adding mechanical stress to a vulnerable healing surface.

The proposed mechanism can therefore be represented as:

bladder filling

↓

wall distension + altered catheter geometry

↓

possible traction/contact at healing tissue

↓

local mucosal or microvascular bleeding

↓

blood accumulates in retained urine

↓

visible red haematuria

followed by:

SPC opened to free drainage

↓

bladder decompression

↓

reduced wall tension and pressure

↓

reduced mechanical irritation

↓

continuous washout of residual blood

↓

pink → pale → clear/yellow urine

This sequence constitutes a **mechanistic hypothesis**, rather than proof of a particular bleeding lesion.

5.4. Why Continuous Drainage May Be Protective

The clinical observation aligns with a fundamental principle of bladder-injury management. The EAU guideline states that continuous drainage is required after bladder injury to prevent elevated intravesical pressure and allow healing.¹ Contemporary surgical literature similarly describes postoperative bladder drainage as lowering intravesical pressure and facilitating

relatively tension-free healing [4]. Decompression therefore does more than remove urine, it changes the mechanical environment of the wound. A continuously drained bladder remains comparatively small. The repair experiences less cyclical distension, while vulnerable mucosa and microvasculature may be exposed to less repetitive movement. The dramatic response observed in this case may therefore represent a visible manifestation of the same principle on which therapeutic bladder decompression is based.

5.5. Alternative Explanations and Differential Diagnosis

The filling-dependent pattern is clinically informative but cannot establish the anatomical origin of bleeding. Several alternative or additional causes need consideration.

5.6. Repair-site bleeding or granulation tissue

Healing tissue itself could provide a small intermittent bleeding source that becomes mechanically stressed during filling.

5.7. Catheter-related mucosal trauma

The catheter tip, balloon or SPC tract can potentially irritate the bladder mucosa. Catheter-associated mucosal injury is documented, while gross haematuria is among reported noninfectious complications of urinary catheterisation [8,10].

5.8. Bladder spasm

Catheter-associated detrusor contractions may intermittently increase pressure or move the bladder wall against the catheter [9].

5.9. Persistent defect or urinary leak

A recurrent or incompletely healed bladder-wall defect must remain part of the differential after bladder injury. Cystography is recommended in selected circumstances to confirm healing, particularly after conservatively treated or complex injuries [1–3].

5.10. Infection or inflammatory cystitis

Urinary tract infection may produce haematuria and may also increase bladder irritability and spasm.

5.11. Calculus, encrustation or foreign material

Catheter encrustation or intravesical calculi can provide a persistent mechanical source of irritation.

5.12. Upper urinary tract bleeding

Renal or ureteric bleeding cannot be excluded purely because urine clears with bladder drainage. A source above the bladder should therefore remain in the differential where clinically appropriate.

5.13. Neoplasia

Unexplained macroscopic haematuria normally requires consideration of urothelial malignancy depending upon age, risk factors and clinical circumstances.

5.14. Anticoagulation or impaired haemostasis

Medication and coagulation status may amplify otherwise minor mucosal bleeding and should be reviewed.

6. What the Rapid Clearing Does—and Does Not—Tell Us

Rapid clearing after bladder decompression is potentially informative: it suggests that red urine need not reflect a continuously high rate of bleeding into the urinary tract.

It is compatible with:

- intermittent mechanically triggered bleeding,
- accumulation of a relatively small quantity of blood during bladder filling,
- cessation or substantial reduction of bleeding following decompression, and
- dilution and washout by newly produced urine.

It is not, however, proof that the bladder repair is intact.

Neither does visually normal urine prove that the underlying mucosa has completely healed.

The distinction is clinically important.

7. Suggested Clinical Correlation

Where this pattern persists following bladder injury, clinical evaluation should be directed toward both the integrity of the repair and potential catheter-related causes.

Depending upon clinical circumstances, assessment may include:

- confirmation of unobstructed SPC drainage and appropriate catheter positioning,
- assessment for catheter traction or balloon-related irritation,
- urinalysis and urine culture where infection is suspected,
- full blood count if bleeding is recurrent or substantial,
- renal function testing,
- medication and anticoagulant review,
- cystography when integrity of the bladder repair is uncertain or when dictated by the type of original injury,
- ultrasonography or cross-sectional imaging where clinically indicated, and
- cystoscopy when persistent bleeding requires direct evaluation of the bladder mucosa, catheter contact region or repair site.

The EAU identifies cystography as an important method of confirming healing in selected bladder injuries and recommends further evaluation where leakage continues [1]. AUA guidance similarly recognises the importance of bladder drainage and follow-up imaging in appropriate bladder trauma [2].

8. Red-Flag Features

While intermittent bleeding can occur with catheterisation and healing, gross haematuria requires greater urgency when accompanied by:

- increasing rather than decreasing bleeding,
- significant clot formation,
- inability of the catheter to drain,
- a distended or painful bladder despite an open drainage system,
- falling haemoglobin or systemic weakness,
- fever, rigors or other evidence of infection,
- increasing abdominal or pelvic pain,
- abdominal distension,
- reduced urinary output,

- suspected catheter displacement, or
- evidence suggesting urinary extravasation.

These features may indicate obstruction, significant haemorrhage, infection, catheter malposition or failure of bladder-wall healing and require timely clinical assessment.

9. Discussion

The particular value of this case lies not simply in the occurrence of haematuria, which is a recognised complication of bladder injury and catheterisation, but in its **dynamic relationship to bladder volume and drainage**.

The patient's own repeated observation effectively creates a natural physiological comparison between two states:

State A: filling bladder

Increasing volume, wall expansion, possible catheter-wall interaction and blood accumulation.

State B: continuously drained bladder

Reduced volume, reduced mechanical loading and continuous clearance of intravesical blood.

The rapid transition between these states supports serious consideration of mechanical factors, but it does not establish causation.

Confirmation would require anatomical and physiological evidence, such as cystoscopic visualisation of a bleeding site, imaging of the repair, assessment of catheter position and, potentially, measurement of bladder pressure.

Nevertheless, the observation is consistent with established bladder biomechanics, recognised catheter complications and the therapeutic rationale for bladder decompression following injury.^{1,3,5,8}

This case therefore illustrates a broader clinical principle: **the timing and circumstances under which a symptom appears may sometimes provide as much mechanistic information as the symptom itself**.

The relevant question is not merely:

“Why is there blood in the urine?”

It is also:

“What changes immediately before the bleeding appears, and what changes when it disappears?”

In this case, the changing variable is bladder filling.

10. Limitations

This report presents a clinical observation and mechanistic interpretation rather than proof of causality. More precise conclusions would require correlation with the operative report, the anatomical site and severity of injury, time since repair, catheter size and balloon volume, microbiology, medication history, cystographic findings, and, where available, cystoscopic examination. Experimental estimates of bladder-wall healing cannot be translated directly into a precise timetable for an individual patient. Similarly, evidence concerning indwelling urethral catheters cannot be extrapolated fully to an SPC.

11. Conclusion

A reproducible pattern of visible haematuria developing during bladder filling and rapidly resolving following continuous SPC drainage has a credible physiological explanation.

The most parsimonious hypothesis is that bladder filling changes the mechanical environment of a still-healing bladder. Progressive distension may place tension across a healing site, alter contact between the catheter and mucosa, stimulate bladder contractions or expose fragile tissue to repetitive mechanical stress. Blood can then accumulate within retained urine.

Free drainage reverses this environment. The bladder decompresses, wall tension falls, mechanical irritation may diminish, and newly produced urine progressively washes accumulated blood from the bladder.

In concise physiological terms:

Filling stretches.

Stretch may irritate.

Irritation may bleed.

Retention concentrates the evidence.

Drainage decompresses.

Decompression permits rest.

Fresh urine washes the residual blood away.

The observation should not be interpreted as reassurance that every episode of post-repair haematuria is benign. Rather, it provides a clinically useful mechanistic clue that warrants correlation with catheter position, bladder-wall integrity and the progress of healing.

The case reinforces an established principle of urological trauma care:

a healing bladder is not merely an organ that requires drainage, it is an organ whose mechanical environment during healing matters.

Learning Points

- Bladder filling changes wall geometry, tissue tension and the relationship between an indwelling catheter and the bladder mucosa.
- Continuous bladder drainage after injury reduces intravesical pressure and mechanical loading and is an established component of bladder-healing management.
- Catheter-associated mucosal injury and bladder spasms provide plausible additional mechanisms for intermittent haematuria.
- Rapid clearing after drainage may reflect both cessation or reduction of a small bleed and continuous dilution and washout of blood that accumulated during bladder filling.
- A reproducible **fill–bleed–drain–clear** sequence is clinically informative but does not establish the anatomical source of bleeding.
- Persistent gross haematuria, clots, impaired catheter drainage, pain, fever, falling haemoglobin or suspected urinary leakage require clinical reassessment.

Declarations

Consent for publication: The author consents to publication.

Conflict of Interest: None declared.

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Central Hypothesis: Filling-associated haematuria may reflect mechanically influenced vesical bleeding in a healing bladder, this is presented as a hypothesis-generating interpretation, not an established diagnosis or proof of a specific bleeding source.

Ethics and Consent: This perspective is an autobiographical reflection written by the person whose experience is described. It reports no research participants, intervention, or systematically collected research dataset. The author consents to publication of the personal clinical material included here.

Data Availability: No research dataset was generated or analysed for this perspective. Clinical details are presented selectively and narratively, source medical records are not publicly available.

Generative AI and Assistive Communication Disclosure

ChatGPT (OpenAI) was used as an assistive communication and manuscript-preparation tool to support organisation, sentence construction, spelling, transcription, and conversion of the author's notes, clinical observations, timelines, and narrative accounts into academic prose. This use was intended to mitigate substantial dyslexia-related writing and sequencing barriers and cognitive fatigue. The author supplied and reviewed the substantive content, clinical facts, interpretations, citations, arguments, and conclusions, retained full editorial control, and accepts responsibility for the manuscript. The tool did not generate research data, determine findings, or qualify for authorship.

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