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Aims and Scope

Korean Journal of Interventional Radiology, the official English-language journal of the *Korean Society of Interventional Radiology (KSIR)*, is an international peer-reviewed academic journal dedicated to interventional radiology. *KJIR* will publish cutting-edge and impactful scientific research articles in the field of interventional radiology.

KJIR will feature peer-reviewed original articles, authoritative reviews, systematic reviews and meta-analysis, case reports, and expert opinion on novel techniques and technologies.

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Inaugural Editorial

Jin Wook Chung*

Department of Radiology, Seoul National University College of Medicine Seoul National University Hospital, Seoul, Republic of Korea

Dear colleagues,

I am pleased to announce the renewal of our official journal. Since its launch in 1995, the *Korean Journal of Interventional Radiology* (KJIR) has played an important role in disseminating cutting-edge techniques and scientific achievements. However, being published only in Korean, it faced certain limitations in reaching the global community. In addition, the absence of an independent website and dedicated resources restricted submissions, with publications concentrated toward the year's end. Most importantly, the lack of a formal peer-review system limited the journal's value as a platform for scientific exchange.

I fully support the decision of the Korean Society of Interventional Radiology to transform KJIR into an English-language journal with its own website. The valuable academic achievements of KSIR and members will be permanently preserved in the KJIR archives and widely disseminated across the globe. I am confident that these changes will enable KJIR to contribute more meaningfully to the global advancement of interventional radiology.

The renewed KJIR will publish case reports, original articles, review articles, systematic reviews, and meta-analyses in the field of interventional radiology. It will be issued biannually, and all manuscripts will undergo a rigorous peer-review process.

I sincerely hope that the scientific innovations shared through KJIR will benefit not only the Korean medical community but also the worldwide interventional radiology society. I warmly encourage my colleagues to submit high-quality original research and to join us in this new chapter of our journal.

Warm regards,
Editor-in-Chief
Jin Wook Chung

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Case Report

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Embolization of Traumatic Ureteric Artery Bleeding: A Case Report

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We present a rare case of traumatic ureteric artery bleeding successfully treated with transcatheter arterial embolization. A 65-year-old male with blunt abdominal trauma and hypotension was found to have a left retroperitoneal hematoma with active extravasation on CT. Initial angiography showed no visible bleeding; however, cone-beam CT revealed active hemorrhage from a ureteric artery displaced by the hematoma. Selective embolization using n-butyl cyanoacrylate and ethiodized oil was performed, resulting in hemodynamic stabilization. Follow-up imaging demonstrated resolution of bleeding and positional change of the ureteric artery as the hematoma resolved. This case highlights the diagnostic value of cone-beam CT and the importance of considering ureteric artery injury in cases of unexplained retroperitoneal hemorrhage.

Keywords: Wounds and injuries; Wounds, nonpenetrating; Embolization; Therapeutic; Ureter

Introduction

Traumatic retroperitoneal hematoma occurs in approximately 67-80% of blunt injuries, and it has been identified in approximately 12% of hemodynamically stable patients with abdominal trauma [1]. Retroperitoneal hemorrhage is often asymptomatic, which may lead to it being overlooked by clinicians, potentially resulting in significant morbidity and mortality. Although there have been reports of transcatheter arterial embolization (TAE) for retroperitoneal hemorrhage involving the lumbar or iliolumbar arteries, no cases have been reported involving traumatic bleeding from the ureteric artery.

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Here, we present a case report of successful TAE for traumatic ureteric artery bleeding, accompanied by detailed imaging findings.

Case Report

A 65-year-old male pedestrian presented to the level I trauma center emergency department following a motor vehicle collision. On arrival, his blood pressure was 60/40 mmHg and his heart rate was 120 beats per minute. Laboratory evaluation revealed a serum hemoglobin level of 12.6 g/dL, a platelet count of 237,000/mm^3, and an INR of 1.02. Contrast-enhanced thoracoabdominal CT, performed to identify possible bleeding sources, demonstrated a left retroperitoneal hematoma with active extravasation (Fig. 1). Associated fractures were noted in the left iliac bone at the anterior superior iliac spine and the left transverse process of L5. There was no evidence of hematuria or hydronephrosis.

An emergent angiographic evaluation and embolization were requested to the interventional radiology team. Selective angiography of the arteries suspected to be potential bleed-

Fig. 1. Preprocedural contrast-enhanced abdominopelvic CT reveals a left retroperitoneal hematoma with associated contrast media extravasation (asterisk).

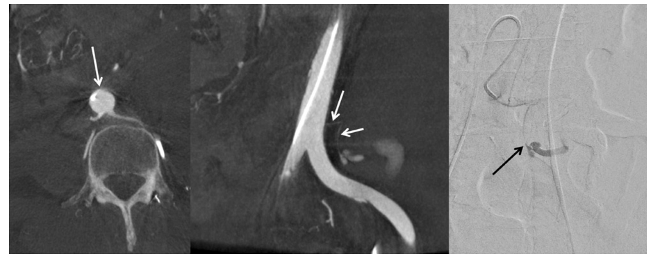

Fig. 2. Axial and coronal cone-beam CT images as well as angiographic image, obtained during the procedure, demonstrate a bleeding left ureteric artery (arrows) originating from the abdominal aorta in the 12 o'clock direction and coursing posterolaterally to the left before sharply angling into an L-shaped configuration.

ers—the adjacent left lumbar arteries, left iliolumbar artery, and left deep circumflex iliac artery—performed with hand injection of contrast medium, revealed no visible contrast extravasation; however, empirical embolization of these arteries was performed using a mixture of n-butyl cyanoacrylate (NBCA) (Histoacryl; B Braun, Rubi, Spain) and ethiodized oil (Lipiodol Ultra; Guerbet Pharmaceuticals, Paris, France) based on the presumption that bleeding may have already ceased. NBCA, a permanent embolic agent, was chosen due to concern that recanalization of the arteries could lead to rebleeding once hypovolemia was corrected and blood pressure increased. As it was considered that all potentially bleeding arteries had been embolized and the patient's vital signs had stabilized, aortography was not performed.

Seven hours after the empirical embolization procedure, the patient remained hypotensive despite intravenous hydration and blood transfusion. Repeat contrast-enhanced CT demonstrated an increase in the size of the left retroperitoneal hematoma with persistent active bleeding. Selective angiography of the infrarenal abdominal aorta branches—including the left renal and renal capsular arteries, left testicular artery, and inferior mesenteric artery—showed no evidence of hemorrhage. As bleeding was presumed to originate from a fine arterial branch not visualized on selective angiography, a 5-Fr diagnostic catheter (pigtail catheter; Jungsung Medical, Seoul, Korea) was positioned in the suprarenal abdominal aorta, and cone-beam CT was performed using a 7 mL/sec injection of a total of 70 mL of contrast (Visipaque 270mg I/ml, GE Healthcare, Shanghai, China).

Axial cone-beam CT images revealed a thin artery arising at the 12 o'clock position from the infrarenal aorta, which coursed leftward toward the left ureter, made an L-shaped bend, and descended, with active bleeding observed (Fig. 2). Based on these findings, selective catheterization of this artery was achieved using the 5-Fr diagnostic catheter (RH; Jungsung Medical, Seoul, Korea) and a 1.5-Fr microcatheter (Veloute Ultra, Asahi Intecc, Nagoya, Japan). Embolization was then performed using a 1:4 mixture of NBCA and ethiodized oil.

Following the procedure, the patient's blood pressure normalized. One month later, a delayed-phase abdominopelvic CT demonstrated embolic material tracking along the course of the left ureter. Notably, when the retroperitoneal hematoma was large, the left ureteric artery appeared to originate at the 12 o'clock position; however, as the hematoma decreased, the origin of the artery was observed to shift to the 3 o'clock position (Fig. 3). During the three-month follow-up period, the patient developed distal ureteral stenosis, which was suspected to result from the ureteric artery embolization. The patient is currently under urological outpatient follow-up with a double-J stent in situ.

Discussion

Traumatic or iatrogenic injury to the ureteric artery is rare. Reports of TAE for such cases are limited to a few case studies; postoperative iatrogenic ureteric artery injury [2,3], and ureteric artery bleeding caused by retroperitoneal invasion due to pelvic lymph node metastasis from gastric cancer [4].

The upper (abdominal) segment of the ureter is primarily supplied by fine ureteric branches originating from the main

Fig. 3. Follow-up CT after hematoma reduction shows the embolized left ureteric artery (arrow) as a hyperdense structure due to the presence of embolic materials. With the hematoma resolved, the artery appears to originate laterally.

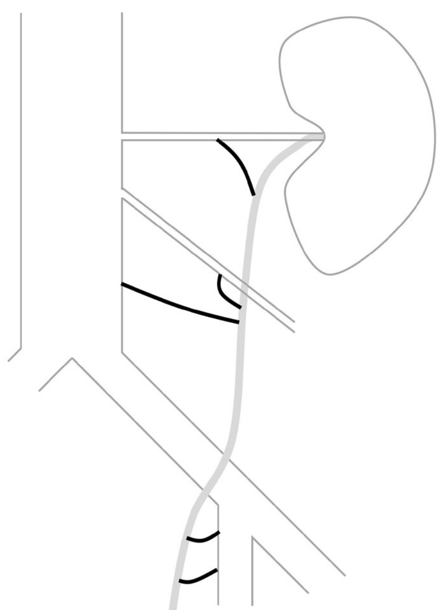

Fig. 4. In this schematic drawing of the segmental arterial supply to the ureteric artery, the supplying arteries are depicted as thick black lines: from top to bottom, the renal artery branch, gonadal artery branch, aortic branch, and multiple branches of the internal iliac artery.

renal artery. Less commonly, arterial supply may also arise from the abdominal aorta or the gonadal arteries. These vessels approach the ureter medially and bifurcate into ascending and descending branches, forming a longitudinal anastomosis along the ureteral wall [5] (Fig. 4). Anatomically, the ureteric artery typically originates laterally from the abdominal aorta. However, in the present case, it appeared to originate anteriorly due to displacement caused by a surrounding hematoma. On follow-up computed tomography, after resolution of the hematoma, the artery was again visualized as originating laterally. This case underscores that an exclusive assumption of a lateral origin from the abdominal aorta may impede the precise identification of the ureteric artery in certain clinical contexts.

In summary, we successfully performed selective embolization of the left ureteric artery, which was the source of bleeding due to traumatic injury, with the aid of cone-beam CT in identifying its origin. During the procedure, possible displacement of surrounding organs and arteries by the hematoma should be considered, and isolated bleeding from fine arteries such as the ureteric artery should be recognized.

Conflict of interest

All authors have no conflicts of interest to declare.

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Author contributions

All the work was done by Suyoung Park.

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Case Report

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Closure of a Misplaced Drainage Catheter Tract in the Stomach Using a Suture-Mediated Vascular Closure Device: A Case Report

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Suture-mediated vascular closure devices (SMVCD) can be applied to close non-vascular structures, although this represents an off-label use. A 53-year-old woman who underwent hysterectomy and chemoradiation therapy due to endometrioid adenocarcinoma two years ago presented for generalized peritonitis due to anastomotic perforation following adhesiolysis and resection. CT revealed multifocal peritoneal abscesses. During perigastric fluid drainage, a pigtail drainage catheter was inadvertently placed into the stomach. To reduce the risk of gastroperitoneal fistula and peritonitis, the gastrostomy site was percutaneously closed using an SMVCD. Immediately after closure, gastrography using orally administered contrast medium and a 10-month follow-up CT demonstrated no leakage or procedure-related complications. This case suggests the potential for safe off-label use of vascular closure devices in the closure of gastrointestinal tract punctures.

Keywords: Vascular closure device; Gastrostomy; Perclose; Percutaneous drainage; Case report

Introduction

Percutaneous drainage (PCD) catheters may occasionally be misplaced during placement for intraperitoneal fluid collections, although such occurrences are rarely reported. Typically, large-bore catheters (> 8 French) are used, standard treatment of gastrointestinal catheter malposition includes either surgical primary closure or catheter removal after long-term indwelling of the catheter under fasting to allow tract maturation. On the other hand, some investigators insisted that catheters can be removed from the stomach without any special measures up to 14 French if fasting is maintained [1]. However, in cases where tract maturation is delayed, such as malnutrition, old age, cancer, chemotherapy, or steroid use, tract closure may be difficult. Several investigators have reported successful gastrostomy repair in swine models using suture-mediated vascular closing devices (SMVCD; Perclose ProStyle, Abbott Vascular, Santa Clara, CA, USA). While the safety and efficacy of SMVCD in vascular closure are well established [2,3], evidence for non-vascular indications was scarce. Here, we report the successful closure of a misplaced gastric PCD tract using an SMVCD.

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Case Report

A 53-year-old woman with a history of total abdominal hysterectomy for endometrioid adenocarcinoma 2 years earlier and subsequent adjuvant chemoradiation therapy presented with adhesive ileus. She underwent adhesiolysis and small bowel resection; however, the surgery was complicated by anastomotic leakage, resulting in the formation of multifocal intraperitoneal abscesses. The perigastric abscess (Fig. 1A) was accessed under ultrasonographic and fluoroscopic guidance. The following day, CT showed an 8.5-French PCD catheter located within the stomach (Fig. 1B).

The cause of malposition was not clear, however, it may have been related to inadvertent advancement of the micropuncture needle or misinterpretation of ultrasonographic findings between the gas-filled stomach and the abscess. A wide space between the stomach and peritoneal wall, along with malnutrition due to prolonged fasting, may hinder normal tract maturation. In addition, instability caused by peristalsis and the lack of an anchoring system–unlike feeding gastrostomy–may further delay tract formation, necessitating safe closure of the perforation. After multidisciplinary discussion, safe retrieval of the PCD catheter was planned using a SMVCD instead of surgical treatment, as the patient had severe radiation-associated fibrosis from prior oncologic treatment. The catheter was exchanged over a 0.035-inch guidewire, and the SMVCD was advanced along the wire (Fig. 2A). The foot was deployed and slightly retracted to achieve secure attachment under fluoroscopic guidance (Fig. 2B). The needles pierced through the gastric wall by pushing the plunger and were then retracted (Fig. 2C), and the puncture site was cinched using the suture trimmer (Fig. 2D).

Post-closure gastrography with water-soluble contrast medium demonstrated no leakage at the puncture site (Fig. 3A). To ensure the safety of closure site and to manage ongoing je-

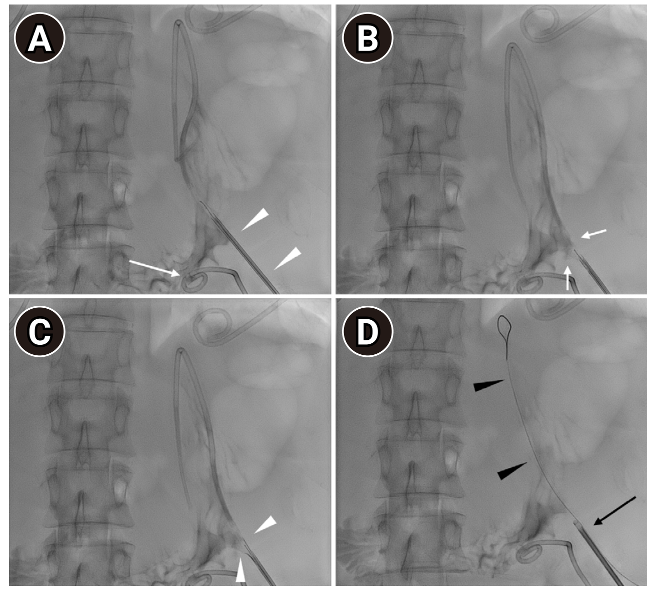

Fig. 2. Closing procedure. (A) An additional catheter was placed for perigastric fluid drainage (arrow). The misplaced drainage catheter was exchanged over 0.035-inch guidewire, and a suture-mediated vascular closing device was advanced along the guidewire (arrowheads). (B) The device foot was deployed and slightly retracted to create tenting of the gastric wall (arrows). Because the foot is radiolucent, proper placement was confirmed by gastric wall configuration. (C) The needles (arrowheads) penetrated the gastric wall upon pushing the plunger. (D) The suture was cinched using the trimmer (black arrow). A 0.018-inch guidewire (black arrowheads) was placed before removal of the SMVCD to allow a second attempt in case of failure.

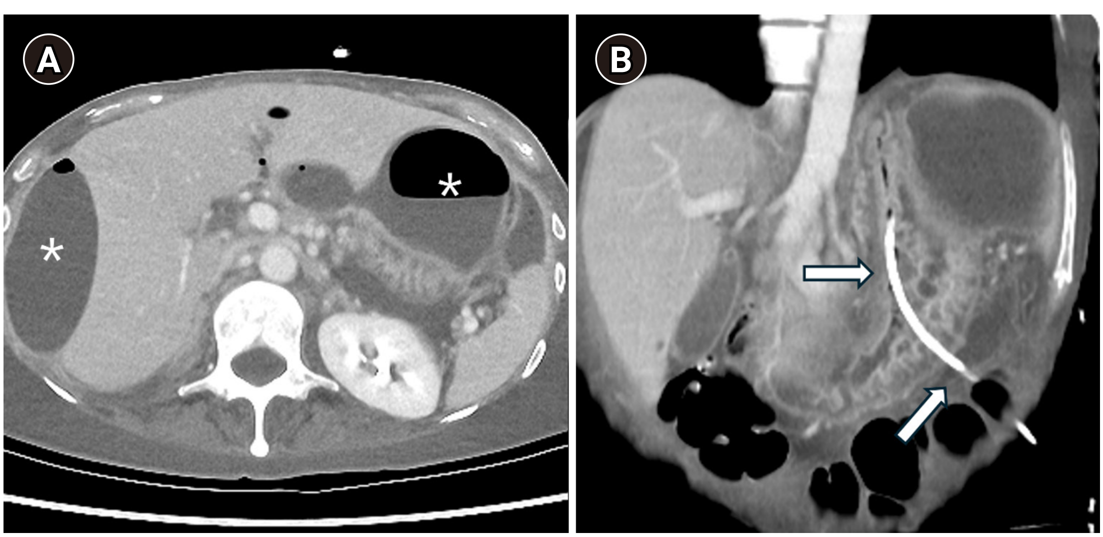

Fig. 1. A 53-year-old woman with a history of adhesiolysis for ileus presented with fever and abdominal pain. (A) Axial CT image shows multiloculated intraperitoneal fluid collections requiring drainage (asterisks). (B) Coronal CT image shows a percutaneous drainage catheter inadvertently placed within the stomach (arrows).

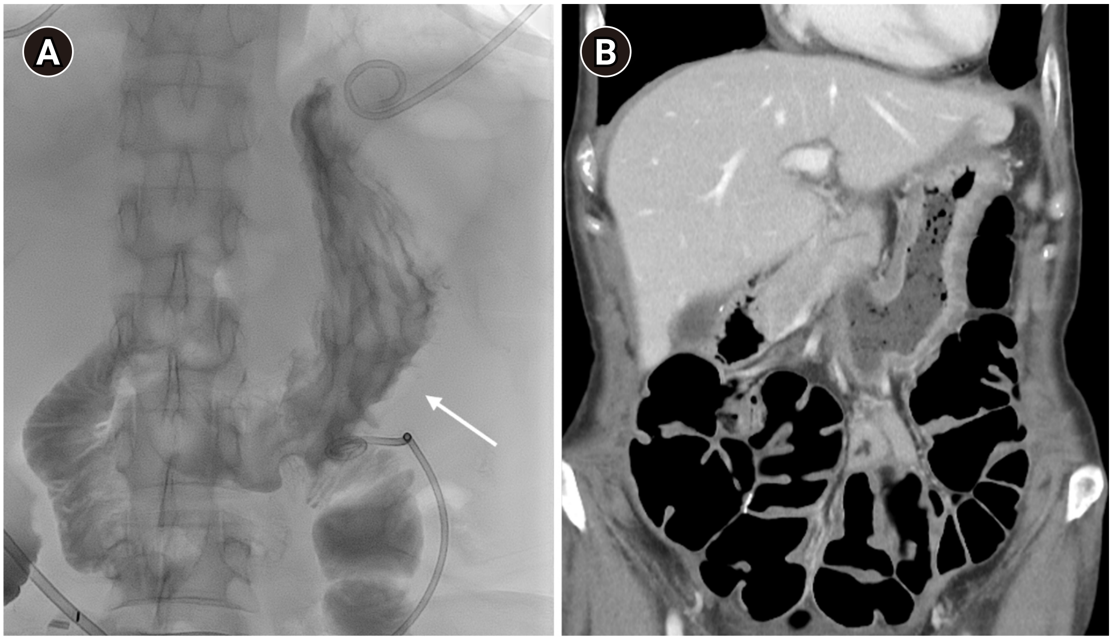

Fig. 3. Follow-up. (A) Immediate post-procedural gastrography with oral contrast medium shows no leakage at the puncture site (arrow) and no structural deformity. (B) Ten-month follow-up CT shows no leakage or deformity of the stomach.

junal leakage, the patient was kept fasting for 6 days before starting a soft diet. The patient subsequently underwent an additional small bowel resection for refractory bowel leakage. Clinical follow-up and CT after 10 months showed no procedure-related adverse events (Fig. 3B).

Discussion

SMVCDs are primarily indicated for the percutaneous delivery of suture for artery or vein to reduce time to hemostasis. Although not as urgent as vascular hemostasis, visceral organ perforations also require secure closure to prevent generalized peritonitis or abscess formation. Conventional percutaneous procedures such as feeding gastrostomy or jejunostomy prevent leakage using fibrosis along the track by long-standing foreign body reaction. However, tract maturation requires a considerable amount of time, and urgent cases often necessitate surgical intervention. The present case demonstrates the potential of SMVCDs to safely repair hollow visceral organ perforations as a less invasive alternative to surgery.

Several investigators have reported the feasibility of using SMVCDs for gastrostomy closure. Cho et al. reported successful closure of gastrostomies in a swine model using a preclosure technique, with no significant adverse events, suggesting the potential clinical applicability of SMVCDs for this indication [4]. In their study, the intraluminal position of the foot was confirmed by injecting a contrast agent via the marker lumen, similar to the technique used in arterial closure. Jung et al. also demonstrated that the use of single or double SMVCDs was feasible and safe for gastrostomy closure in a swine model [5]. Similarly, Shlomovitz et al. reported successful SMVCD-assisted closure of gastrostomies created for duodenal stent placement in a porcine model [6]. In contrast, Mueller et al. reported 11 cases of safe removal of misplaced catheter during abdominal drainage with no additional procedure; however, the catheters had been left in place for an average of 17 days [1]. Surgical repair may provide a straightforward treatment option for misplaced catheters. Several reports have also described misplaced cystostomy catheters in the gastrointestinal tract that were successfully treated with laparoscopic repair [7,8]. Our case provides additional evidence supporting the safe application of SMVCDs for gastrostomy closure under fluoroscopic guidance.

Several considerations are necessary before the use of SMVCDs in non-vascular organs. First, although they may be applicable to organs such as the small and large intestine, urinary bladder, and gallbladder, device limitations must be considered. The sheath length restricts feasibility in the urinary bladder and gallbladder unless the distal sheath is shortened. Secondly, the target organ should be located within approximately 6 cm of the skin to accommodate the guide tube length; deeply located puncture sites are less suitable. Furthermore, the mobility of the small intestine may hinder accurate deployment. Thirdly, unlike in blood vessels, no blood regurgitates through the proximal marker. Proper positioning can be confirmed by fluoroscopic imaging or injection of a contrast agent through proximal marker lumen. In addition, the success of closure could be verified by fluoroscopic imaging using a contrast medium. Fourthly, current recommendations for vascular applications limit use to arteries < 21 French and veins < 24 French, however, no guidelines exist for visceral organs [2]. Further clinical studies are warranted to evaluate the safety and efficacy of SMVCDs for gastrointestinal applications.

This report describes a single case, and therefore, generalizability is limited. Broader clinical experience is required to establish the safety and efficacy of SMVCDs in non-vascular applications.

Conflict of interest

Dong Jae Shim has been the Deputy Editor of Korean Journal of Interventional Radiology. However, He was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

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Author contributions

All the work was done by Dong Jae Shim.

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Review Article

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Interventional Radiology in the Management of Urologic Trauma: A Contemporary Review

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Urologic trauma encompasses a spectrum of injuries involving the kidney, ureter, bladder, and urethra, with management strategies increasingly emphasizing organ preservation through minimally invasive, image-guided approaches. The updated American Association for the Surgery of Trauma 2025 grading system provides the most recent guideline for renal trauma classification, reflecting evolving imaging standards and management principles. In parallel, interventional radiology (IR) has assumed an increasingly important role in contemporary trauma care, offering effective, organ-preserving solutions through endovascular and percutaneous techniques. Renal trauma, the most frequent form of genitourinary injury, is now primarily managed non-operatively in hemodynamically stable patients, with transcatheter arterial embolization and stent-based repair serving as cornerstones of hemorrhage control and renal salvage in high-grade lesions. Clinical evidence demonstrates that selective or superselective embolization achieves high technical success and renal preservation, consolidating IR as a key component of multidisciplinary trauma management. Injuries to the lower urinary tract remain complex, but minimally invasive, image-guided interventions are increasingly recognized as integral to modern care, particularly in controlling hemorrhage and preserving function. Superselective embolization, percutaneous urine diversion, and fluoroscopic urethral realignment exemplify how IR provides life-saving, organ-preserving options for ureteral, bladder, and urethral trauma. Collectively, these developments underscore the expanding impact of IR across the full spectrum of urologic trauma management.

Keywords: Urologic injuries; Kidney injuries; Interventional radiology; Embolization, Therapeutic; Endovascular procedures

Introduction

Urologic trauma encompasses a wide spectrum of renal and lower urinary tract injuries, each with distinct diagnostic challenges and management considerations [1-8]. Advances in multidetector computed tomography (MDCT) have markedly improved detection of vascular and collecting system injuries [1], and the 2025 update of the American Association for the Surgery of Trauma (AAST) Kidney Injury Scale reflects these contemporary imaging standards [9]. In parallel, interventional radiology (IR) has become increasingly central to trauma care, offering minimally invasive, organ-preserving options for hemorrhage control and urinary tract reconstruction [10-15].

This review provides an updated overview of renal-trauma mechanisms, imaging evaluation, and the revised AAST 2025 classification, with emphasis on the indications, techniques, and outcomes of IR-based management. It also summarizes the expanding role of image-guided interventions in ureteral, bladder, and urethral trauma, presenting an IR-focused

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framework to support decision-making across the full spectrum of urologic trauma.

Part 1. Kidney

Mechanisms of Renal Injury

Blunt Trauma

The kidney, a retroperitoneal organ shielded by ribs, Gerota's fascia, and perirenal fat, is most often injured by blunt mechanisms such as motor vehicle collisions or falls [6, 7]. Injuries range from cortical laceration to perirenal hematoma and, in severe cases, complete parenchymal rupture [6,7]. Renal trauma occurs in approximately 8–10% of patients with abdominal trauma [6]. Hemorrhage may extend into the collecting system, producing gross or microscopic hematuria [12,16].

High-energy deceleration injury, typical of high-speed collisions, can cause renal artery dissection, thrombosis, or avulsion [17-23]. Data from the National Trauma Data Bank report renal artery injury in 0.05% of blunt trauma cases, accounting for 2.5–4% of all renal injuries, more often than in penetrating trauma [7]. Hematuria may be absent, delaying diagnosis [7]. Renal artery occlusion usually follows intimal disruption and thrombosis [17-19]. On contrast-enhanced CT, global nonenhancement with a delayed cortical rim sign suggests collateral perfusion [4,18].

Penetrating Trauma

Penetrating renal injuries—including stab, gunshot, and iatrogenic tract injuries from nephrostomy or biopsy—create narrow parenchymal tracts and carry a high risk of arterial disruption, pseudoaneurysm, or arteriovenous fistula (AVF) [16,24]. Patients often present with persistent hematuria, occasionally progressing to hemodynamic instability or hemorrhagic shock [16,25-27].

Iatrogenic vascular injury is increasingly observed due to the widespread use of percutaneous nephrostomy, lithotripsy, and renal biopsy. Vascular complications after biopsy, including AVF, were among the first indications for selective renal embolization. Delayed bleeding from pseudoaneurysm or AVF remains a characteristic presentation [28].

Imaging Evaluation

Historically, retrograde ureteropyelography and intravenous pyelography were used to evaluate renal trauma but were limited in assessing parenchymal integrity and are now obsolete [3].

Ultrasonography (US) is a rapid, bedside, noninvasive tool in acute trauma, mainly for detecting intraperitoneal fluid within the Focused Assessment with Sonography for Trauma, commonly known as the FAST protocol. However, its sensitivity for retroperitoneal hemorrhage and solid organ injury is limited [5,29].

Contrast-enhanced CT (CECT) is now the diagnostic gold standard for suspected renal injury [1,4,30,31]. Modern MDCT provides rapid, high-resolution imaging even in unstable patients, delineating laceration depth, arterial extravasation, segmental devascularization, urinary extravasation, and associated abdominal trauma through arterial, venous, and delayed phases [3]. CT is essential in patients with gross hematuria, those with microscopic hematuria and hemodynamic instability, or those sustaining high-energy mechanisms [1,4,30,31].

Conventional angiography, once a diagnostic modality, is now primarily therapeutic. It is reserved for endovascular management of traumatic AVF, pseudoaneurysm, or active arterial bleeding, and for targeted assessment of renovascular injury when CT is inconclusive [28,32-36].

Classification of Renal Trauma

The AAST Kidney Injury Scale remains the standard framework for grading renal trauma [8,9,28]. Earlier versions focused on laceration depth and perirenal hematoma, whereas the 2025 update incorporates contemporary CT features and links injury patterns to expected management, emphasizing collecting system disruption, segmental devascularization, and major vascular injury [2,9,30]. In this revision, perirenal hematoma is quantitatively assessed using the hematoma radial distance (HRD), defined as the longest perpendicular distance from the renal parenchymal surface to the outer hematoma margin within the superior–inferior boundaries of the kidney. HRD thresholds now contribute to distinguishing lower-grade from higher-grade contusions and lacerations [9].

High-grade categories now include active arterial extravasation, urinary leak, segmental vascular injury, and main hilar disruption, which correlate with the need for IR-directed therapy rather than immediate nephrectomy [28,37]. The scale ranges from minor subcapsular hematoma or contusion (grades I–II) to deep laceration with urinary extravasation or segmental devascularization (grade IV) and to shattered kidney or hilar avulsion with global devascularization (grade V).

The 2025 revision also integrates IR algorithms: grades I–II are observed; most grade III and many grade IV lesions are managed non-operatively with transcatheter arterial embolization (TAE) when active bleeding or expanding hematoma is present; and even selected grade V cases may be treated with embolization or stent repair if hemodynamic stability is achieved [33,34,36]. This evolution reflects the shift from mandatory nephrectomy to kidney-preserving, image-guided therapy in stabilized patients [33,34,36]. Imaging criteria extracted from the AAST 2025 Kidney Injury Scale are presented in Table 1.

Management Strategies

The main goals in renal trauma management are rapid hemorrhage control, renal preservation, and prevention of complications such as urinary leakage or sepsis [8,11,38-40]. Modern practice favors non-operative or minimally invasive management supported by advances in CT imaging, critical care, and endovascular techniques [1,6,10,13,36,41,42].

Blunt Renal Injury

Blunt trauma accounts for most renal injuries. Low-grade (AAST I–II) lesions, nearly 75% of cases, usually heal with conservative treatment—hemodynamic monitoring, transfusion as needed, and serial hematocrit checks [12,16,37].

Management of grades III–IV is individualized. In hemodynamically stable patients, non-operative management is generally feasible. The AAST 2025 revision defines active arterial bleeding as a grade IV criterion, underscoring selective or superselective TAE as an appropriate intervention [9,28,37,42]. Embolization is indicated when CT shows active extravasation, enlarging hematoma, or segmental vascular injury [33,34,36].

Surgical exploration is now limited to refractory hemodynamic instability, combined visceral injury,or major urinary extravasation with > 50% devitalized parenchyma. Even in grade V injuries, published clinical experiences demonstrate that selective embolization can achieve kidney preservation in selected stable patients [33,36]. Kwon et al. [34] demonstrated that superselective TAE can be effectively applied even in grade V renal trauma, yielding high technical and renal-preservation success. These results support its adoption as a viable first-line option for hemodynamically stabilized patients whenever feasible.

Penetrating Renal Injury

Penetrating trauma—typically stab or gunshot wounds—has a higher incidence of vascular injury, pseudoaneurysm, and AVF formation [16]. Management parallels that of blunt injury: hemodynamic stabilization, bleeding control, and renal preservation.

Non-operative management is suitable for stable patients with limited parenchymal disruption and minimal urinary

Table 1. Kidney Organ Injury Scale (AAST 2025, Imaging Criteria Only)

AAST Grade	Imaging Criteria
I	Subcapsular hematoma < 3.5 cm without active bleeding; parenchymal contusion without laceration.
II	Parenchymal laceration length < 2.5 cm; HRD < 3.5 cm without active bleeding
III	Parenchymal laceration length ≥ 2.5 cm; HRD ≥ 3.5 cm without active bleeding; partial kidney infarction; vascular injury without active bleeding; laceration extending into urinary collecting system and/or urinary extravasation
IV	Active bleeding from kidney; pararenal extension of hematoma; complete/near-complete kidney infarction without active bleeding; MFK without active bleeding; complete/near-complete ureteropelvic junction disruption.
V	Main renal artery or vein laceration or transection with active bleeding; complete/near-complete kidney infarction with active bleeding; MFK with active bleeding.

Grade based on highest grade assessment made on imaging, at operation or on pathologic specimen. Each kidney should be graded separately based on the highest grade injury it contains. Multiple injuries are not upgraded to a higher level of injury. Grade III vascular injuries are contained vascular injuries, which do not result in active bleeding. These include pseudoaneurysm, arteriovenous fistula, dissection, thrombosis, intimal flap, and mural hematoma. Active bleeding occurs with uncontained (laceration or transection) injuries. On imaging, active bleeding is defined as presence of vascular contrast extravasation seen as a collection of vascular contrast outside of a vessel, demonstrated on arterial or venous or delayed phase. Hematoma around the kidney is measured by HRD and is defined as the longest perpendicular distance from the renal parenchymal border to the hematoma border within the boundaries of superior and inferior kidney margins. This is measured on axial CT images and on the bulk of the hematoma. It does not include a thin sliver of hematoma that extends beyond the bulk of the hematoma or bleeding originating from other organs. Pararenal hematoma is defined as a hematoma that crosses the right border of the IVC for a right-sided bleed, or the left border of the aorta for left-sided bleed, or extends beyond the aortic bifurcation inferiorly. Multifragmented kidney is defined as three or more injured parenchymal segments with fluid or blood between. Renal laceration is defined by its longest length on a single axial image.
AAST, American Association for the Surgery of Trauma; HRD, hematoma rim distance; MFK, multifragmented kidney; CT, computed tomography; IVC, inferior vena cava.

leak [12]. Embolization serves as an adjunct or alternative to surgery when localized arterial bleeding or pseudoaneurysm is identified [16,43]. In unstable patients or those with bowel contamination, surgical exploration or nephrectomy remains necessary.

Delayed hemorrhage—2–3 weeks after injury—is common in penetrating or high-grade trauma due to pseudoaneurysm or AVF formation and is usually controlled by targeted embolization [16,19].

Renal Artery Injury

Renal artery trauma (AAST IV–V) includes dissection, thrombosis, and avulsion, often resulting in devascularization [17-19]. Treatment options comprise nephrectomy, surgical repair, endovascular intervention, or observation. Ischemia beyond two hours generally causes irreversible damage [17,19,32,41].

Endovascular stent placement has largely replaced open repair, offering effective revascularization with lower morbidity [44]. Stent-graft repair is preferred for focal dissection or partial avulsion of the main renal artery with preserved distal flow, while TAE remains the treatment of choice for active bleeding or pseudoaneurysm [44]. These endovascular approaches illustrate the principle of image-guided hemorrhage control and renal salvage over nephrectomy whenever anatomically possible [23,43,45].

Endovascular Techniques

Endovascular therapy is central to modern renal-trauma care, providing rapid hemostasis and renal preservation while avoiding nephrectomy [23, 45]. Two main approaches are used—TAE and endovascular stent-graft placement—depending on vascular injury pattern and hemodynamic status.

Indications and Timing

TAE is indicated for active arterial extravasation in AAST IV–V injuries, pseudoaneurysm, AVF, delayed hemorrhage, and rebleeding after transient stabilization [33,34,36]. It may also be applied prophylactically when a transected segmental artery carries a high rupture risk [33,34,36].

Damage-control interventional radiology—often referred to as DCIR—prioritizes expedient hemostasis over exhaustive superselective attempts; if microcatheterization fails within ~10 minutes, proximal or sacrifice-level embolization is justified to save life before organ [46].

Technical Considerations

Initial angiography with abdominal aortography defines renal arterial anatomy and accessory branches [45]. Coaxial microcatheter systems permit superselective access to segmental branches, minimizing infarction [34]. Superselective TAE is ideal when feasible, whereas proximal embolization may be necessary in unstable patients for damage control [45,46].

Embolic Materials

Choice of embolic agent depends on vessel size and bleeding pattern. Gelatin sponge is preferred for diffuse low-pressure bleeding because it provides temporary occlusion. N-butyl cyanoacrylate (NBCA) offers rapid permanent occlusion for distal or multifocal bleeding. Coils are used for large or high-flow AVFs; detachable types allow precise deployment and reduce migration risk [13,35,45].

Endovascular Stent Placement

Stent-graft placement is indicated for main renal-artery dissection, avulsion, or focal transection with potential for revascularization [20-23,47]. It is also used for contained hemorrhage with preserved distal flow or iatrogenic rupture. Microguidewires and angled sheaths facilitate precise deployment.

Both balloon-expandable and self-expanding stents achieve effective revascularization and exclude extravasation, providing a kidney-preserving alternative to nephrectomy [14,21].

Contraindications and Complications

No absolute contraindications exist, but care is required in patients with renal dysfunction or infection because contrast administration may worsen the injury [45]. In solitary kidneys, maximal selectivity is recommended, although life-saving embolization takes precedence.

Complications include puncture-site bleeding, non-target embolization, and coil migration, which can be corrected with a snare catheter. Post-embolization syndrome—flank pain, leukocytosis, and low-grade fever—usually resolves within 48 hours with supportive care [34,36].

Clinical Outcomes

Renal embolization was first described by Bookstein et al. [24] in 1973 for post-biopsy AVF treatment and has since become integral to renal-trauma management. The evolution of therapy over the past two decades highlights the transition from surgical to conservative and endovascular approaches for high-grade (AAST IV–V) injuries (Table 2).

In a retrospective clinical series, Kwon et al. [34] achieved an 81% technical success and 79% renal-preservation rate in patients with grade V injuries treated with superselective TAE, reinforcing that endovascular management ensures durable hemostasis and organ salvage even in complex high-grade vascular trauma. Brewer et al. [33] similarly achieved hemostasis without nephrectomy in nine unstable grade V patients and reported durable renal function on follow-up.

Santucci et al. [35] noted that over 78% of high-grade injuries were surgically managed in 2000, whereas May et al. [40] later documented 75% non-operative management—illustrating the paradigm shift toward IR-based care. Hagiwara et al. [14] prospectively treated grade III–V injuries with early angiography, achieving embolization success in 8 of 21 patients and > 90% avoidance of laparotomy. These findings confirm that TAE achieves rapid hemostasis and renal salvage even in high-grade trauma.

For renovascular trauma, Whigham et al. [23] first applied endovascular stenting in 1995; subsequent studies demonstrated durable perfusion and parenchymal preservation [20,22,47]. Although short-term results are excellent, long-term renal-function data remain limited, underscoring the need for multicenter registries [10,13].

Grange et al. [10] reported 93.7% clinical success in 79 emergency renal embolizations with minimal rebleeding and no major complications. Collectively, evidence from 2000–2025 supports TAE and stent-based therapy as front-line modalities for hemodynamically stabilized high-grade renal trauma, markedly reducing nephrectomy rates and preserving renal function [13,33,34,36]. Continuous advances in embolic materials, rapid trauma imaging, and integration of interventional radiologists within trauma teams will further enhance outcomes and consolidate endovascular therapy as the standard of care for complex renal injuries [13].

Part 2. Ureter

Epidemiology and Mechanisms

Ureteral injury is uncommon, accounting for less than 1% of all genitourinary injuries [48], yet it is clinically significant because of delayed diagnosis and the potential for urinoma, infection, and ischemic stricture [49]. Iatrogenic injury during gynecologic or colorectal procedures remains the most frequent cause, but blunt or penetrating trauma can also damage small peri-ureteral branches, producing concealed retroperitoneal bleeding [50]. When hemodynamic instability or unexplained hematoma persists, selective angiography should be considered.

Imaging Evaluation and Diagnosis

CECT with delayed excretory phase provides the initial

Table 2. Management trends and outcomes in high-grade (AAST IV–V) renal trauma

Study	Year	No. of Cases (Gr IV, V)	Management of Grade IV Injury	Management of Grade V Injury	Key Findings / Relevance to IR
Santucci et al. [35]	2000	2,047* (not stratified)	22% conservative / 9% nephrectomy / 69% renorrhaphy		Early era showing surgery dominant.
Kuo et al. [39]	2002	95 (16, 8)	56% conservative / 25% nephrectomy / 19% exploratory	25% conservative / 63% nephrectomy	Initial shift toward selective non-operative approach.
Wright et al. [8]	2006	6,892 (530, 228)	78% conservative / 22% nephrectomy	44% conservative / 56% nephrectomy	Large registry showing growing non-operative trend.
Elashry et al. [11]	2008	72 (57, 15)	84% conservative / 16% surgical	20% conservative / 80% surgical	IR emerging as bridge to surgery.
Dugi et al. [38]	2010	33 (33,0)	4A: predominantly conservative; 4B: higher need for intervention	–	Proposed Grade IV risk stratification, supporting selective intervention and predominant non-operative care.
May et al. [40]	2016	47 (39, 8)	97% conservative / 3% surgical	75% conservative / 25% surgical	Contemporary series confirming conservative success.
Kwon et al. [34]	2022	16 (0, 16)	–	81% technical success, 79% renal preservation, 0% mortality after superselective RAE	Demonstrated effective superselective RAE with meaningful renal parenchymal salvage.
Grange et al. [10]	2024	79 (5, 7)	93.7% clinical success, 3.8% re-embolization	Preserved renal function in > 90% of cases	Confirms modern endovascular therapy as first-line for severe renal bleeding.

Abbreviations: AAST, American Association for the Surgery of Trauma; RAE, Renal Arterial Embolization; IR, Interventional Radiology.
*Grade-specific (AAST IV–V) case numbers were not available in the original publication; total cohort size is shown.

roadmap for identifying contrast leakage or abrupt cutoff [51]. Minor arterial bleeding is often angiographically occult, but cone-beam CT (CBCT) can reveal subtle pseudoaneurysms arising from ureteral branches. Park et al. demonstrated that CBCT can localize bleeding points otherwise invisible on standard angiography, guiding rapid and precise embolization [52].

Interventional Techniques and Outcomes

Under fluoroscopic guidance, a 1.5–1.7 Fr microcatheter is advanced into the affected ureteric branch arising from the renal artery, aorta, or common/internal iliac artery. NBCA diluted with iodized oil or detachable coils are selected according to flow and anatomy. Superselective embolization achieves immediate hemostasis without compromising ureteral perfusion. In Park's case, clinical result was favorable, with no ischemic strictures on follow-up [52]. Case reports by Maleux et al. [49] and Kase et al. [50] documented durable control of postoperative or iatrogenic bleeding after microcoil or NBCA embolization. More recently, Saiga et al. [51] reported pseudoaneurysms in ureteral branches of the renal artery successfully treated by combined NBCA-coil therapy. These results confirm that distal embolization is both safe and definitive when performed under flow control. Across contemporary literature, technical success of ureteric-branch embolization approaches 100%, with negligible ischemic complications [49-52].

Part 3. Bladder

Epidemiology and Mechanisms

Bladder trauma represents approximately 1–2% of genitourinary injuries and is frequently associated with pelvic fractures or penetrating pelvic wounds. Most extraperitoneal ruptures heal with catheter drainage, while intraperitoneal dome ruptures require surgical repair. However, focal arterial bleeding from the vesical branches of the internal iliac artery constitutes a specific subset in which IR plays a hemostatic role [53].

Interventional Techniques and Outcomes

The superior and inferior vesical arteries supply the bladder base and dome through anastomotic channels. Injury to these vessels—whether iatrogenic, traumatic, or postoperative—can result in massive hematuria. When cystoscopy fails to localize the bleeding focus, angiography can demonstrate extravasation along the bladder wall. Superselective embolization is performed with a microcatheter advanced into the vesical branch under roadmap guidance. Embolic agents include gelatin sponge, microcoils, or NBCA depending on vessel caliber and accessibility. Early reports, including Kim et al. [54], showed that distal or superselective vesical artery embolization can achieve immediate hemostasis without significant ischemic complications. A recent case report by Vanheer et al. [53] further confirmed complete bleeding control and preserved bladder function following bilateral vesical artery embolization.

When urethral catheterization is contraindicated, percutaneous suprapubic cystostomy performed by interventional radiologists under image guidance provides urinary diversion and pressure relief, facilitating healing of extraperitoneal tears. Complications such as bladder necrosis are now exceptional and linked to older, non-selective embolization practices. Modern IR techniques using microcatheters and controlled embolic material delivery ensure organ preservation and functional recovery [53,54].

Part 4. Urethra

Epidemiology and Mechanisms

Urethral injuries, particularly those associated with pelvic fracture, remain among the most challenging problems in urologic trauma. They account for approximately 10% of genitourinary trauma and carry high morbidity due to the risk of incontinence, impotence, and recurrent stricture [55,56].

Endovascular Management of Hemorrhage

Although urethral trauma typically presents with urinary retention and extravasation rather than active bleeding, recent literature has reported rare but significant arterial hemorrhage. De Bondt et al. described two cases of post-traumatic urethral hemorrhage originating from arteriospongious fistulae, successfully managed by superselective embolization with microcoils and an ethylene-vinyl alcohol–based liquid embolic agent, achieving complete hemostasis without ischemic complications [57]. This finding expands the role of IR in urethral trauma to include targeted embolization for refractory hemorrhage.

Fluoroscopic Urethral Realignment

Posterior urethral injury differs fundamentally from anterior injury in its mechanism and management. While anterior urethral injuries usually result from straddle trauma or instrumentation and can often be managed conservatively with catheter drainage, posterior urethral disruptions occur almost exclusively with pelvic fractures. In these cases, shearing forces separate the membranous urethra from the prostatic apex, creating complete luminal discontinuity surrounded by hematoma and soft-tissue distortion, conditions that complicate endoscopic repair [58-67].

Under combined ultrasound and fluoroscopic guidance, a percutaneous cystostomy tract is first created into the bladder to secure antegrade access. A 4 or 5-Fr angiographic catheter is inserted, and contrast is injected to delineate the proximal urethral stump. This step provides spatial orientation for aligning the disrupted segments. Through the retrograde route, a hydrophilic guidewire and angled catheter are advanced from the external meatus toward the site of disruption under fluoroscopy. The two approaches are visualized simultaneously with biplane fluoroscopy, allowing real-time assessment of the proximal and distal stumps in orthogonal projections.

When the luminal ends can be approximated, the retrograde wire is advanced into the bladder to establish a direct channel. If the two lumina cannot be directly traversed, a snare catheter introduced through the cystostomy tract can capture the retrograde wire to create a through-and-through connection. This technique is particularly valuable when hematoma or displacement prevents direct passage [15]. Once the continuous tract is established, a 14–18 Fr Foley or silicone catheter is gently advanced across the defect with the balloon seated in the bladder. The catheter is typically left in place for 4–6 weeks to permit epithelial healing and mucosal alignment. Follow-up voiding cystourethrography is performed prior to catheter removal to confirm continuity and absence of urine leakage [15].

This fluoroscopic realignment has the advantage of avoiding the need for lithotomy positioning or general anesthesia in patients with pelvic fractures, making it particularly suitable for polytrauma settings [15]. This sequence demonstrates the coordinated precision of IR and urology in re-establishing urethral continuity through minimally invasive, image-guided realignment and emphasizes the principle of functional restoration with minimal disruption, integrating radiologic precision into traditional reconstructive paradigms.

Conclusion

Renal trauma management has evolved toward organ-preserving, minimally invasive strategies, supported by diagnostic and therapeutic advances in MDCT and IR, as well as by the updated AAST 2025 grading system. While most low-grade injuries recover with conservative treatment, TAE and stent-based techniques now constitute the cornerstone of hemorrhage control and renal salvage in high-grade trauma. The integration of IR into trauma care has markedly improved both survival and kidney-preservation outcomes.

Injury to the lower urinary tract remains a multidisciplinary challenge, with the role of interventional radiology still limited but steadily expanding through accumulating experience and research. Early diagnosis and minimally invasive, image-guided interventions are increasingly recognized as integral to modern management, particularly in controlling hemorrhage and preserving function. Superselective embolization, percutaneous urine diversion, and fluoroscopic urethral realignment exemplify how IR offers life-saving, organ-preserving solutions for ureteral, bladder, and urethral trauma.

Author contributions

Conceptualization, investigation, and manuscript writing: C.H.J. All aspects of the work were performed by the corresponding author.

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Conflict of interest

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Instructions for authors

KJIR
Korean Journal of
Interventional Radiology

These guidelines outline the requirements for submitting manuscripts to the Korean Journal of Interventional Radiology (KJIR). Authors should ensure their submissions meet the formatting standards, article type specifications, ethical requirements, and follow the proper submission process.

Table of Contents

Aims and scope

Korean Journal of Interventional Radiology, the official English-language journal of the Korean Society of Interventional Radiology (KSIR), is an international peer-reviewed academic journal dedicated to interventional radiology. *KJIR* will publish cutting-edge and impactful scientific research articles in the field of interventional radiology.

KJIR will feature peer-reviewed original articles, authoritative reviews, systematic reviews and meta-analysis, case reports, and expert opinion on novel techniques and technologies.

Contact Information

KJIR Editorial Office
Room 1401, 42, Seocho-daero 78-gil, Seocho-gu, Seoul 06626, Republic of Korea
Tel: 02-465-9070, Fax: 02-465-9072
E-mail: editor@kjironline.org

Publication and Research Ethics

The *KJIR* follows international standards for peer-reviewed journals in interventional radiology (IR), in line with guidelines used by major IR journals and recommendations by the International Committee of Medical Journal Editors (ICMJE) and Committee on Publication Ethics (COPE).

Statement of Human and Animal Rights and Informed consent

Human and Animal Rights

All studies involving human subjects must comply with the ethical principles outlined in the Declaration of Helsinki and must be approved by an appropriate institutional review board (IRB) or ethics committee. Authors must provide a statement within the manuscript confirming IRB approval and adherence to ethical guidelines.

For studies involving animals, authors must confirm compliance with institutional and national guidelines for the care and use of laboratory animals. Experiments should follow the ARRIVE

(Animal Research: Reporting of In Vivo Experiments) guidelines and be approved by the appropriate animal ethics committee.

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If informed consent was not required for the study, a clear statement explaining the exemption should be included in the manuscript.

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For case reports, informed consent may be waived if the study is retrospective and does not include identifiable personal information. Authors must ensure that patient confidentiality is strictly maintained. If identifiable patient details (such as images or medical history that could lead to identification) are included, authors must obtain explicit written informed consent from the patient or their legal guardian before submission.

The authors should state in the manuscript whether informed consent was obtained or if an IRB waiver was granted.

Informed consent is an ethical requirement for case reports involving identifiable patient information. However, in certain circumstances, a waiver of informed consent may be acceptable. Authors may request a waiver if the following conditions are met:

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2. The study or case report has received approval or exemption from the relevant institutional review board (IRB) or ethics committee, specifically indicating that informed consent is not necessary.
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3. **Final approval** of the version to be published.
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- Handling responses to reviewers and providing any additional data or clarification as requested.
- Confirming that all authors have approved the final version of the manuscript.

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The authors declare that there are no conflicts of interest related to this study.

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Author A has received research grants from [Company Name]. Author B serves as a consultant for [Company Name]. Author C holds stock in [Company Name]. These relationships had no influence on the study design, data interpretation, or manuscript preparation.

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Authorship and Author's Responsibility

Data Sharing Policy and Responsibility

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All submitted manuscripts must include a **Data Availability Statement** that specifies:

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- The names and locations (city and state/province or country) of the manufacturers of equipment and generic names should be given.
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- Refer to the most recent articles published in KJIR for style.

Article Types

Original Research

- **Scope:** Should present novel techniques, significant new data, or new insights in interventional radiology.
- **Structure:** IMRaD format: **Introduction, Materials and Methods, Results, and Discussion.**
- **Length:** Maximum **3,500 words** (excluding abstract, references, tables, and figure legends).
- **Abstract:** Up to **250 words,** structured (Purpose, Materials and Methods, Results, Conclusion).
- **References:** Up to **40 references.**
- **Tables/Figures:** Maximum **5 tables** and **7 figures**.

Review

- **Scope:** Provide a comprehensive analysis of a topic in interventional radiology.
- **Structure:** Flexible, but typically includes **Introduction, Subsections, and Conclusion.**
- **Length:** Maximum **4,000 words.**
- **Abstract:** Up to **250 words,** systematic review: structured (Background, Methods, Results, Conclusion), narrative review: unstructured typically one or two paragraph.
- **References:** Up to **100 references.**
- **Tables/Figures:** Maximum **10 figures** and **5 tables.**

Case Report

- **Scope:** Describe unique cases, novel techniques, or rare complications.
- **Structure: Introduction, Case Report, Discussion.**
- **Length:** Maximum **2,500 words.**
- **Abstract:** Up to **125 words,** unstructured.
- **References:** Up to **15 references.**
- **Tables/Figures:** Maximum **3 tables** and **7 figures.**

Technical Note

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- Length: Maximum **2,500 words.**
- Abstract: Up to **250 words,** structured.
- References: Up to **15 references.**
- Tables/Figures: Maximum **5 tables** and **7 figures.**

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- **Scope:** Commentary or perspective on interventional radiology topics.
- **Invitation:** Typically invited; unsolicited editorials should be pre-approved by the Editor-in-Chief.
- **Length: 1,000–1,500 words.**
- **References:** Minimal (typically 5–10 references).

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- Length: Maximum **1,200 words** in text and **6 minutes** in video.
- **References:** up to 5 references.

Ethical Considerations

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- **Informed Consent:** Case reports and any articles including identifiable patient information require written informed consent.
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Submission Process

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1. **Manuscript Information** – Enter title, authors, affiliations, and article type.
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5. **Review and Submit** – Ensure compliance with guidelines and finalize submission.

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  Individuals who contributed to the work but who did not meet the requirements for authorship should be included in the acknowledgments.

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All figure parts related to one patient should have the same figure number and use English letters after the numerals to distinguish each figure part, e.g., Fig. 1A, 1B, etc.

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Labels and arrows should be presented with a professional appearance.

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- Manuscripts undergo peer review by at least two experts in the field.
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- Example

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Article in press.

Ko E, Kim J, Gwon DI, Chu HH, Kim GH, Ko GY. Emergency Plug-Assisted Retrograde Transvenous Obliteration (PARTO) for Active Bleeding from Ruptured Gastric Varices. *J Vasc Interv Radiol.* 2025 Feb 1 [Epub] http://doi.org/10.1016/j.jvir.2025.01.049

Books

Binkert CA, Inferior vena cava filters. In: Mauro MA. Image-guided interventions. 2nd ed. Philadelphia, PA: Elsevier, 2014; e105-e110.

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By adhering to these guidelines, authors contribute to the quality and impact of the *Korean Journal of Interventional Radiology*.

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- ☐ Cover letter.
- ☐ All texts files in Microsoft Word format (doc or docx).
- ☐ Complete Full Title Page as a separate Microsoft Word file
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