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Selective Embolization of Arteriovenous Malformation in Gross Hematuria Post-Renorrhaphy: A Case Report

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Abstract: Management approaches for renal trauma vary from conservative methods for contusions to surgical interventions for severe injuries. Postoperative renal artery embolization (RAE) is crucial to control bleeding and preserve renal parenchymal tissue integrity. We reported a patient presented with hematuria 30 minutes after sustaining a stab wound to the right waist, accompanied by severe pain, dizziness, and cold sweats. Physical examination revealed a penetrating wound in the right flank, gross hematuria, and signs of hypovolemic shock. The patient was diagnosed with grade II hypovolemic shock due to a renal laceration and duodenal rupture, initial resuscitation and conservative management were followed by exploratory laparotomy and renorrhaphy. Persistent gross hematuria post-renorrhaphy necessitated embolization. Hypovolemic shock resulted from significant bleeding from duodenal and renal lacerations. Renorrhaphy effectively minimized renal parenchymal damage without urine extravasation. Subsequent angiography revealed gross hematuria, indicating renal arteriovenous malformation (AVM). Embolization using a vortex coil successfully managed bleeding from large vessels and improved perfusion in the lesion area. In conclusion, renal trauma poses serious risks, including hypotension and hemorrhagic shock. Prompt resuscitation followed by surgical repair and angiographic embolization are essential. Embolization remains a generally safe and effective method for achieving selective hemostasis in such cases.
Keywords: renal trauma; gross hematuria; renorrhaphy; renal-artery embolization

INTRODUCTION

The kidneys are solid organs that commonly experience trauma, either penetrating trauma or blunt trauma. Approximately 3.25% of all trauma patients are renal trauma patients.[1] The most common mechanism for renal trauma is blunt trauma (predominantly by motor vehicle accidents and falls), while the rest is penetrating trauma (mainly caused by firearms and stab wounds).[2] Renal trauma accounts for 40% of genitourinary trauma with 24% of solid organ trauma, third rank before spleen and liver.[3] Early symptoms and signs of kidney trauma include gross hematuria or microscopic hematuria and hypotension. Abdominal CT examination should be performed if the mechanism of injury or physical examination shows suggestive of renal injury (e.g rapid deceleration, rib fractures, flank ecchymosis, and any penetrating injury of the abdomen, flank or lower chest).[4]

Management of kidney trauma has evolved over time, with a clear shift toward a nonsurgical strategy. Minimally invasive therapy up to laparotomy surgery are all possible treatments for kidney trauma. Management really depends on the classification of severity of renal injury. Invasive management is indicated for renal trauma with hemodynamic disturbances, with clinical symptoms such as gross hematuria, and injury grading according to the American Association for the Surgery of Trauma (AAST) above 2 or renal laceration.[5]

Conservative management includes bed rest, analgesics, hemodynamic monitoring, serial laboratory assessment, and reimaging if the condition worsens is indicated with minimal symptoms, or renal contusion. In cases of life-threatening renal trauma, rapid and appropriate management, especially immediate surgical interventions such as ureteral stent installation, laparotomy, open nephrectomy, renorrhaphy, or embolization must be carried out immediately as final treatment, to stop bleeding and prevent the patient's vital worsening.[6]

Renal artery embolization (RAE) is an effective minimally invasive alternative procedure for the treatment of a variety of conditions. Since the 1970s when RAE was first developed, technical advances and growing experience have expanded the indications to not only include treatment of conditions such as symptomatic hematuria and palliation for metastatic renal cancer vascular malformations, medical renal disease, and complications following renal intervention.[7] Postoperative RAE is recommended to stop bleeding characterized by gross hematuria, stop the spread of infection, and maintain adequate parenchymal tissue.[8] Renal trauma is a case with an incidence of 1-5% with a fairly high mortality and morbidity rate. Renal trauma can be prevented with adequate management and stopping bleeding either by laparotomy, renorrhaphy or injection of embolization agents. Therefore, researchers want to know more about the clinical symptoms and prognosis of kidney trauma cases that receive post-operative laparotomy, renorrhaphy and embolization.[3] We would like to present a case report on a patient who underwent post-operative selective renal artery embolization with indications of gross hematuria after an exploratory laparotomy intervention with renorrhaphy for penetrating renal injury at Prof. Hospital. Dr. R.D. Kandou, Manado.

CASE REPORT

A male patient came to the emergency department with complaints of bloody urine since 30 minutes ago, it was discovered that previously he had been involved in an argument and was stabbed in the right side of the waist. Another complaint was stab wounds on left thigh. There is active bleeding, pain with 6-7 degree of VAS. The patient complained of dizziness, accompanied by cold sweat. The patient complained of nausea without vomiting. The patient denied of abdominal pain, decreased consciousness, fever, and defecation disorders. On physical examination blood pressure dropped, respiration increased, and heart rate increased. In the right flank region was found a *vulnus ictum* with 5 cm x 0.5 cm in size, unknown depth, active bleeding, clear boundaries, no contusion. In the left femoral region was found a *vulnus laceratum* with 5 cm x 3 cm x 0.5 cm size, tissue base, active bleeding, uneven borders, no contusion. The active

bleeding caused the patient to fall into a state of hypovolemic shock. On Laboratory examination hemoglobin decreased to 8.1, and was found gross hematuria. CT-scan shows that the patient suffered grade 2 right renal laceration and pars 2 duodenal rupture. The patient was diagnosed with Gross Hematuria + Grade 2 Right Renal Laceration + Pars 2 Duodenal Rupture + Grade II Hypovolemic Shock.

The patient received two-line crystalloid fluid resuscitation, cross match prior to PRC transfusion, and was given vasopressor to stabilize the vital signs. Situational suturing was performed on the right flank region and left femoral region to control bleeding. The patient was then consulted to the urology department and received immediate laparotomy followed by renorrhaphy. Conservative management for the patient includes crystalloid fluid 1500 ml/24 hours, ceftriaxone injection 2 g as a prophylactic antibiotic, ketorolac injection 30 mg/ 12 hours as an analgetic, ranitidine injection 50 mg/ 12 hours, tranexamic acid injection 500 mg/8 hours, and phytomenadione injection with dose of 10 mg/ 8 hours to control bleeding.

After laparotomy and renorrhaphy were carried out, hematuria was observed. The patient was referred to the thoracic and vascular surgery department for selective embolization with indication of renal arteriovenous malformation (AVM) in gross hematuria. The patient was in general anesthesia and angiography was performed with the impression of an AVM in the interlobar artery at the inferior pole of the right kidney. The next intervention was selective embolization with a microcatheter and 0.014 wire which was cannulated into the proximal part of the AVM. The 3 x 3 mm vortex coil was pushed with coil pusher. Evaluation angiography was performed and results showed that the AVM area was not filled with contrast, as it performed on Fig. 1. Following the procedure, the patient had a clear-yellowish urine with no signs of bleeding. The patient was allowed ambulatory care with routine control.

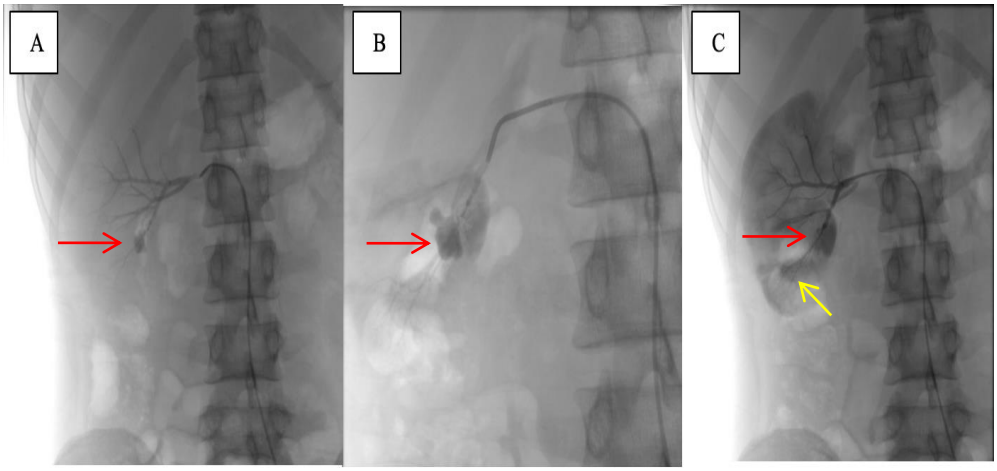

Figure 1. Renal angiography before (A and B) and after (C) renal artery embolization. A, Arteriography of the right renal artery demonstrate a small vascular fistulous connections between renal arteries and veins (red arrow); B, Magnified image of a fistulous connection (red arrow); C, After Transcatheter arterial embolization of the left renal, arteriography shows disappearance of renal AVM (red arrow), and arcuate arteries (yellow arrow)

DISCUSSION

Renal trauma occurs in 80–95% of urogenital trauma cases and 8–10% of blunt abdominal trauma.[9] In this case, the patient sustained a stab wound in the right flank region. Renal trauma is classified according to etiology into blunt trauma and penetrating trauma. Most penetrating renal trauma has a worse prognosis because the kidneys are more damaged than blunt trauma. Renal trauma is often caused by firearms (83–86%) and stab wounds (14–17%). Renal penetrating trauma is divided into several classifications such as; high-velocity projectiles (e.g. rifles), medium velocity (e.g. handguns) and low velocity (e.g. knife stab). Position of the puncture affects the treatment given, if the puncture is towards the anterior part of the abdomen, it is likely

to hit vital organs of the renal structure such as the renal pelvis and vascular pedicle. If the puncture goes from the posterior to the anterior axillary line, it is very likely that it will hit the renal parenchyma without affecting the vital organs of the renal structure. In this case, patient blood pressure dropped to 90/60 mmHg with an increased heart rate to 128 beats/minute, patient required rapid and more interventional management, because it was suspected that the puncture affect vital organs in the renal pelvis and renal arteriovenous. Penetrating renal trauma that affects vital areas is characterized by massive hematuria with extreme hypotension, it can cause hypovolemic shock and sudden death.[10]

On CT-scan, shows that the patient suffer grade 2 right renal laceration. The classification of kidney trauma according to AAST is divided into 5 stages, according to the level of severity. Epidemiologically. Injury severity distribution according to the AAST classification: grade I, 22–28%; grade II, 28–30%; grade III, 20–26%; grade IV, 15–19%; and grade V, 6–7% (Table 1).[5] In this case, the patient has been classified as having a grade II renal laceration, which involves minimal damage to the renal parenchyma without any urine extravasation. The patient's hypovolemic shock could potentially be attributed to the injury and hyperactivation of the adrenal glands, followed by duodenal rupture.

After assessing vital signs post-laparotomy, persistent signs of bleeding were observed. Subsequently, angiography was conducted to identify potential bleeding sites within the renal region. During angiography with contrast administration, an arteriovenous malformation (AVM) in the right kidney was discovered. Following this finding, the thoracic and cardiovascular surgery department decided to proceed with post-operative embolization. This comprehensive approach aimed to manage both the immediate surgical needs and the underlying vascular anomaly contributing to the patient's condition.[11]

Renal embolization is a minimally invasive medical procedure involving deliberate blockage of renal vascular to treat various medical conditions.[11] This procedure is often used to control bleeding, and treat blood vessel malformations, main indications for renal artery embolization include; arteriovenous fistula (spontaneous or iatrogenic), renal vascular malformation, life-threatening hematuria, aneurysm or pseudoaneurysm of renal artery, preventive measures for tumor infarction before resection or ablation, and palliative measures for renal tumors. Superselective renal embolization involves injecting contrast dye through the renal artery via transfemoral access. Microcatheters are used to carefully embolize specific branches of the renal artery by inserting them coaxially over a guidewire.[12] The choice of embolization material depends on the patient's vascular anatomy and the specific clinical condition being treated.[13] Options such as resorbable agents, coils, inert particles, and sclerosants (liquids) are chosen based on the targeted vascular structure and clinical requirements. The primary goal is to block branches with hemorrhagic extravasation while sparing surrounding vessels to minimize damage to the kidney tissue.[14]

In this case, super-selective embolization technique using a 3 x 3 mm vortex coil was performed. The use of this metal coil was indicated for renal arteriovenous malformation (AVM), where there were symptoms of decreased blood flow in the lesion area. After the embolization procedure post-operation, no complications were observed. Complications associated with renal artery embolization include postembolization syndrome, which presents with symptoms such as nausea, vomiting, fever, leukocytosis, and abdominal pain resulting from damage to the renal parenchyma.[15] Other possible complications include hematoma at the catheter insertion site, renal failure, and temporary hypertension. Studies indicate that embolization for iatrogenic renal artery injuries generally does not lead to long-term increases blood pressure or significant impairment of kidney function.[16] There are various reports on complications associated with arteriovenous embolization in renal management post-surgery. One of the most common complications is unintended peripheral artery embolization in the lower extremities due to reflux or embolus dislodgement, which can occur in 10% of cases.[17] Follow-up was conducted on the patient, revealing a normal condition without embolus reflux.

Table 1. AAST renal injury scale[5]

AAST	Imaging criteria (CT Findings)	Operative goals	Pathological criteria
I	Subcapsular hematoma and/or parenchymal contusion without laceration	Non-expanding subcapsular hematoma Parenchymal contusion without laceration	Subcapsular hematoma and/or parenchymal contusion without laceration
II	Peri-renal hematoma confined to Gerota fascia Renal parenchymal laceration ≤1 cm depth without urinary extravasation	Non- expanding peri-renal hematoma confined to Gerota fascia Renal parenchymal laceration ≤1 cm depth without urinary extravasation	Peri-renal hematoma confined to Gerota fascia Renal parenchymal laceration ≤1 cm depth without urinary extravasation
III	Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation Any injury in the presence of a kidney vascular injury or active bleeding contained within Gerota fascia	Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation	Renal parenchymal laceration >1 cm depth without collecting system rupture or without urinary extravasation
IV	Parenchymal laceration extending into urinary collecting system with urinary extravasation Renal pelvis laceration and/or complete ureteropelvic disruption-Segmental renal vein or artery injury Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding	Parenchymal laceration extending into urinary collecting system with urinary extravasation Renal pelvis laceration and/or complete ureteropelvic disruption Segmental renal vein or artery injury Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding	Parenchymal laceration extending into urinary collecting system with urinary extravasation Renal pelvis laceration and/or complete ureteropelvic disruption Segmental renal vein or artery injury Segment or complete kidney infarction(s) due to vessel thrombosis without active bleeding
V	Main renal artery or vein laceration or avulsion of hilum Devascularized kidney with active bleeding Shattered kidney with loss of identifiable parenchymal renal anatomy	Main renal artery or vein laceration or avulsion of hilum Devascularized kidney with active bleeding Shattered kidney with loss of identifiable parenchymal renal anatomy	Main renal artery or vein laceration or avulsion of hilum Devascularized kidney with active bleeding Shattered kidney with loss of identifiable parenchymal renal anatomy

CONCLUSION

Renal trauma is the most frequent injury among solid organs, often resulting in life-threatening complications due to hypotension and hemorrhagic shock. Immediate management including packed red blood cell transfusion and crystalloid fluid resuscitation is crucial. Further intervention frequently becomes necessary to repair renal lacerations. Sometimes, certain lesions cannot be addressed through exploratory interventions. Angiographic embolization serves as a means to control bleeding. This procedure can be performed either before or after surgical intervention, depending on specific goals and indications. Embolization is generally considered a safe method for selective hemostasis, albeit it is somewhat invasive.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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