

Interventions in Trauma

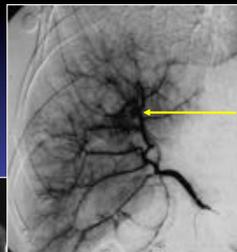
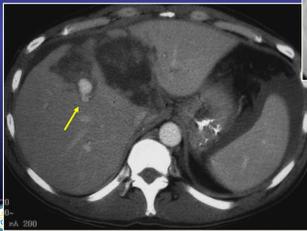
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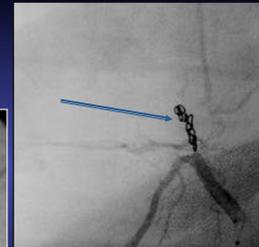
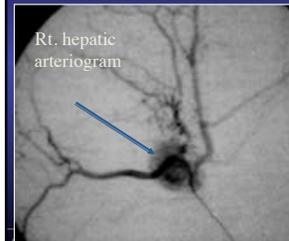
Angiography before or after Damage Control Laparotomy

- Kushimoto et al (J Trauma 2003) reviewed 20 patients undergoing DCL of which 8 also had Angiography and Embolization
- Indications were hematomas seen on CT or at surgery
- Higher % survival in those undergoing both procedures

40 y/o male post blunt trauma, bleeding



Hepatic angiography with embolization



Pelvic trauma

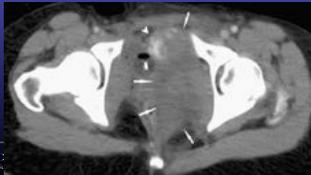
- Trauma accounts for one in ten deaths worldwide
- Pelvic fractures indicate transfer of high energy in severe blunt trauma (MVA and falls from great height)
- Sharp bone fragments and shear forces may cause direct vascular injury and lead to arterial hemorrhage
- Mortality rates from hemodynamic instability due to pelvic trauma range from 18%-40%

Risk factors for pelvic arterial hemorrhage

- Anteroposterior compression injury (front-end vehicle collision, falls) – may open pelvic ring, places internal iliac artery and branches at risk.
- Lateral compression injury (pedestrian hit from side by motor vehicle) – may damage iliac vessels or retropubic veins.
- Poor hemodynamic status or recurrent hypotension despite resuscitation efforts.
- Contrast extravasation on CT scan.

Pelvic trauma and hemorrhage – diagnostic approach

- Contrast extravasation on multidetector CT in hemodynamically unstable patient without other source of hemorrhage suggests pelvic source of bleed.
- Most commonly injured arteries – superior gluteal, internal pudendal, lateral sacral, ilio lumbar, inferior gluteal arteries.

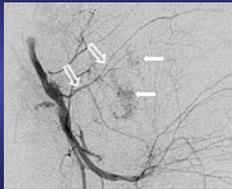


Axial CT demonstrates pelvic hematoma (white arrows) with extravasation of contrast (arrowhead).

Pelvic trauma and hemorrhage – endovascular management

- Catheter-based intervention with arteriogram should be performed when contrast extravasation seen on CT in hemodynamically unstable patient (Vaidya et al. J Am Acad Ortho Surgeons, 2018)
- Pelvic angiogram and subsequent selective internal iliac angiography often identify vascular injury.
- Selective catheterization performed with 4-5 French visceral catheter and hydrophilic 0.035-inch angled guidewire.
- Positive findings – active contrast extravasation, vasospasm, arterial transection, AV fistula, pseudoaneurysm.

Pelvic trauma and hemorrhage – endovascular management



Angiogram with multifocal extravasation of contrast from the left ilio lumbar artery?

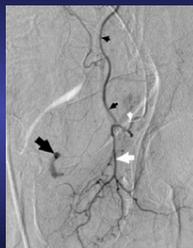


Single focus of contrast extravasation at the origin of the superior gluteal artery?

Pelvic trauma and hemorrhage – endovascular management

- Following identification of bleeding site, embolotherapy employed.
- For pelvic trauma, embolization less focused and non-selective to quickly control multiple bleeds and hemorrhagic shock.
- Empiric embolization of bilateral internal iliac arteries often necessary for hemodynamically unstable patients, however has become controversial
- Embolic agents – absorbable gelatin sponge (gelfoam) for temporary occlusion; coils for permanent occlusion.

Pelvic trauma and hemorrhage – endovascular management



Selective arteriogram with contrast extravasation from the obturator artery surge.



Occlusion of obturator artery with demonstrated control of bleeding.

What are possible complications

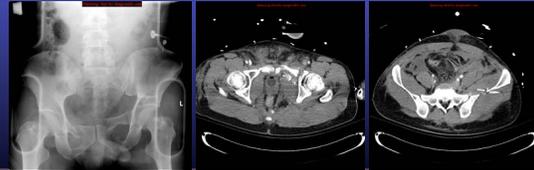
- Has become controversial with increase in empiric, bilateral, gelfoam embolization which became popular in 1990's
- Reports of surgical wound breakdown, gluteal muscle necrosis, nerve injury, bowel infarction, etc.
- However, these patients often have multiple causes for these issues
- Does appear to be some (poor) evidence that bilateral empiric embolization increases the risks (Travis et al. JVIR, 2008)
- What is clear is that the procedure is life-saving and complications are rare, however, most operators will reserve empiric embolization for severely ill, exsanguinating patients

Case #1 clinical history

- 33-year-old man thrown from motorcycle and subsequently run over by SUV.
- Primary survey – rigid abdomen, large abrasions over lower back and bilateral flanks. Vascular exam normal.
- During CT scan, patient became hypotensive and was immediately sent for exploratory laparotomy.
- No solid organ injury apparent, retroperitoneal bleed discovered and packed. Patient sent to IR for embolization of suspected pelvic bleed.

Case #1 diagnostic imaging

CR and CT abdomen and pelvis – multiple bilateral pelvic fractures: comminuted right and left superior pubic rami, comminuted left inferior pubic ramus, right inferior pubic ramus, left acetabulum, diastases of bilateral SI joints.



Case #1 diagnostic imaging

3D reconstruction of multiple bilateral pelvic fractures.

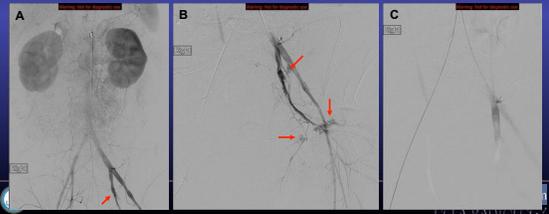


Case #1 angiography and intervention

(A) Abdominal aortography with active extravasation from proximal left internal iliac artery.

(B) Selection of left internal iliac artery, arteriogram demonstrated diffuse irregularity of vessel with multiple sites of extravasation.

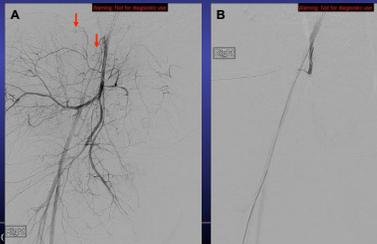
(C) Following gelfoam embolization, complete stasis seen within the vessel.



Case #1 angiography and intervention

(A) Selection of right internal iliac artery with several small sites of extravasation, mostly in posterior division.

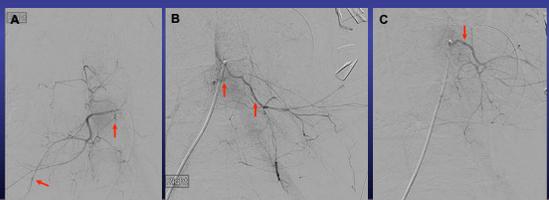
(B) Following gelfoam embolization, complete stasis is seen in the vessel.



Case #1 angiography and intervention

Angiography of (A) right L1, (B) left L1, (C) L2 lumbar arteries demonstrated evidence of extravasation.

Following gelfoam embolization, complete stasis is seen in these vessels (not shown).



Case #1 patient outcomes

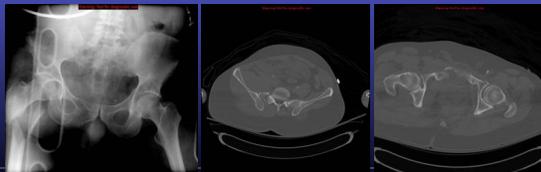
- Following embolization, patient remained hemodynamically stable enough for repair of multiple injuries.
- Underwent repair of ruptured bladder; screw fixation of T11-L1, ORIF left hemipelvic fracture and restoration of left iliac wing anatomy.
- Patient tolerated all procedures well and was eventually discharged to acute rehabilitation.

Case #2 clinical history

- 33-year-old man fell from great height in suicide attempt.
- Primary survey – significant abrasions over lower extremities, gross deformity of right thigh with swollen right thigh compartment.
- Vascular exam – 1+ right lower extremity pulses distal to femoral, 2+ left lower extremity pulses.
- Given obvious deformity of thigh and pelvic injury on imaging, patient transferred emergently to angiography suite.

Case #2 diagnostic imaging

CR and CT abdomen/pelvis – pelvic hematoma extending to right thigh, bilateral sacral fractures, fractures of right pubic bone, anterior left acetabulum, right inferior pubic ramus, intertrochanteric region right femur. Contrast extravasation noted at multiple fracture sites.



Case #2 angiography and intervention

- (A) Initial angiography with multiple foci of contrast extravasation from internal iliac branches.
(B) Selection of right internal iliac artery with prominent areas of contrast extravasation.
(C) Gelfoam embolization of right internal iliac artery with stasis of flow.



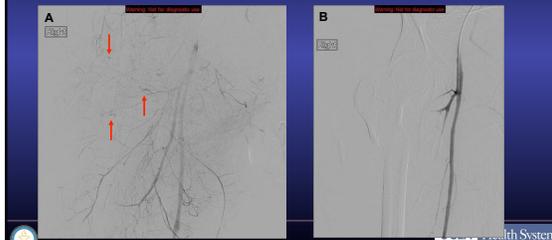
Case #2 angiography and intervention

- (A) Selective left internal iliac artery with multiple foci of active bleeding.
(B) Embolization with gelfoam performed; stasis of vessel is achieved.



Case #2 angiography and intervention

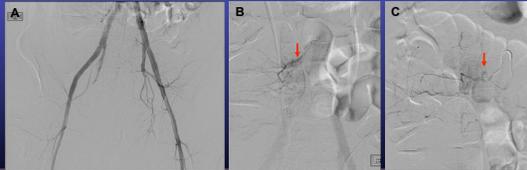
- (A) Branches of the right deep femoral artery with multiple foci of contrast extravasation, likely due to intertrochanteric femoral fracture.
(B) Embolization with gelfoam performed; stasis of vessel is achieved.



Case #2 patient outcomes

Following embolization, patient's transfusion requirements remained high – returned to angiography suite that evening.

(A) Repeat angiography showed recanalization of left internal iliac artery and (B) bleeding from right L1-L5 lumbar arteries (L1-L2 shown below). These vessels were all embolized.



Case #2 patient outcomes

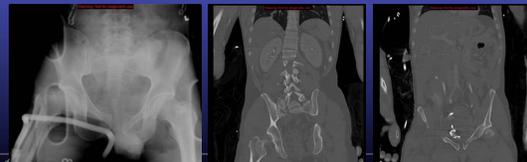
- Following second embolization, patient remained hemodynamically stable.
- Returned to OR for multiple procedures: ORIF right femur and bilateral sacral fractures.
- Patient was evaluated by psychiatry.
- Discharged 28 days after original admission to acute rehabilitation.

Case #3 clinical history

- 32-year-old man fell 35 feet from the roof of a building in a suicide attempt.
- Primary survey – hypotensive despite resuscitative efforts. Tender right hip with swelling of right thigh; high suspicion for pelvic fracture and pelvic hematoma.
- Vascular – normal pulses all extremities.
- Patient sent for exploratory laparotomy and packing of pelvic hematoma.

Case #3 diagnostic imaging

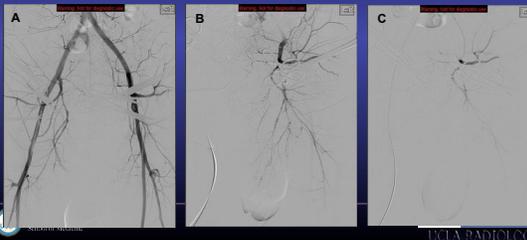
CR and CT abdomen and pelvis - Diastasis pubic symphysis x 2.3cm, left superior pubis fracture, S1 transverse process fracture with extension into right sacral ala, comminuted right femur intertrochanteric fracture. Given multiple pelvic fractures, patient was sent to angiography suite.



Case #3 angiography and intervention

(A) Pelvic arteriogram from the distal aorta demonstrated no contrast extravasation, multiple vessel narrowing likely due to spasm.

(B) Selection of anterior division of left internal iliac artery indicated vessel spasm; (C) gelfoam embolization achieved stasis of flow.



Case #3 angiography and intervention

(A) Selection of anterior division of right internal iliac artery indicated small area of contrast extravasation at region of symphysis pubis. (B) Post-gelfoam embolization with stasis of flow in the vessel.



Case #3 patient outcomes

- Patient did well after embolization and remained hemodynamically stable.
- Subsequently returned to OR for ORIF subtrochanteric femur fracture, ORIF sacral fracture, repair of symphysis pubis.
- Patient was evaluated by psychiatry and cleared for discharge to rehabilitation on hospital day 19.

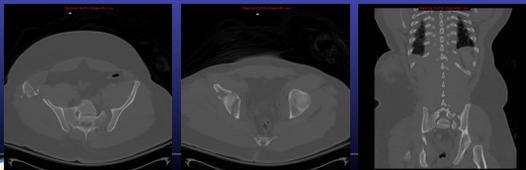
Case #4 clinical history

- 30-year-old motorcycle driver struck by automobile and was thrown ten feet. Patient landed on right side of body.
- Primary survey – transverse abrasions over right side and right flank with tenderness to palpation over right hip and femur.
- Vascular exam – distal pulses 2+ bilateral lower extremities.
- Hemocues stable in resuscitation suite.

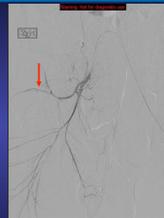
Case #4 diagnostic imaging

CT abdomen and pelvis – comminuted fractures of right ischium, acetabulum, iliac bone and left sacrum with diastases of symphysis and left sacroiliac joint.

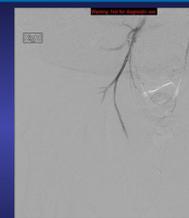
Given multiple pelvic fractures, vascular injury suspected and patient was sent to angiography suites.



Case #4 angiography and intervention



Arteriogram of right internal iliac artery with faint contrast extravasation at level of superior gluteal artery.



Gelfoam embolization performed at this vessel with stasis of flow in follow-up arteriogram.

Case #4 angiography and intervention



Arteriogram of left internal iliac artery without evidence of contrast extravasation.



Gelfoam embolization performed at this vessel with stasis of flow in follow-up arteriogram.

Case #4 patient outcomes

- Following embolization, patient returned to OR for repair of multiple injuries.
- ORIF left sacral fracture, right hemipelvis, right acetabulum, multiple debridement right iliofemoral wound – tolerated all surgeries well.
- Hospital stay unfortunately complicated by continuous infections and fluid accumulation around pelvic hardware.
- Was eventually discharged to home five months after original admission.

Case #5 clinical history

- 24-year-old woman struck by automobile while riding moped.
- Primary survey – obvious pelvic injury with 10-cm wide-open skin flap over right thigh.
- Vascular exam – normal left lower extremity pulses; right popliteal, dorsalis pedis, posterior tibialis pulses nonpalpable and not present to Doppler.
- Hemocues downtrending in resuscitation suite but with stable blood pressures and heart rate.

Case #5 diagnostic imaging

CR pelvis – diastases right sacroiliac joint; comminuted right acetabular fracture; fractures of right anterior pubic tubercle, left superior and inferior pubic rami.



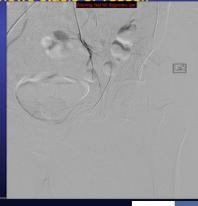
Given multiple pelvic fractures and downtrending Hemocues, pelvic bleed suspected and patient sent to angiography suites.

Case #5 angiography and intervention

Selective angiogram demonstrated contrast extravasation at left internal pudendal artery.

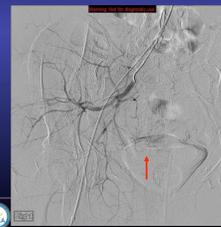


Catheter advanced to origin of left internal pudendal artery. Gelfoam embolization performed. Postembolization angiography shows stasis of vessel.

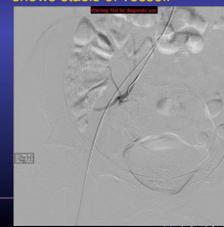


Case #5 angiography and intervention

Selective angiogram demonstrated contrast extravasation at right obturator artery.

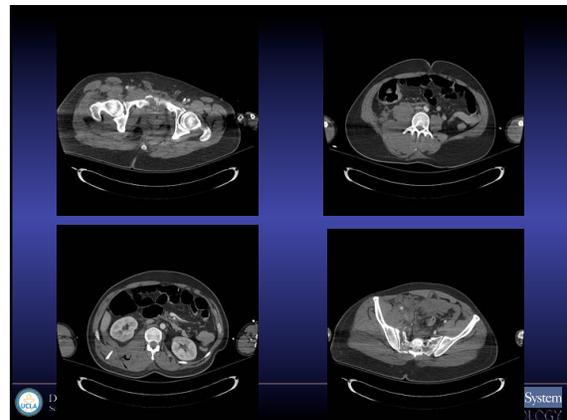


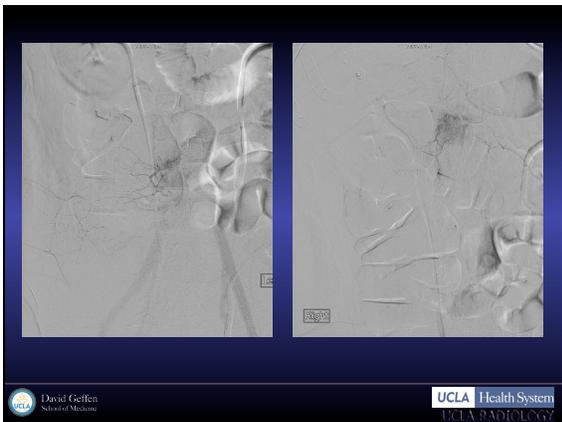
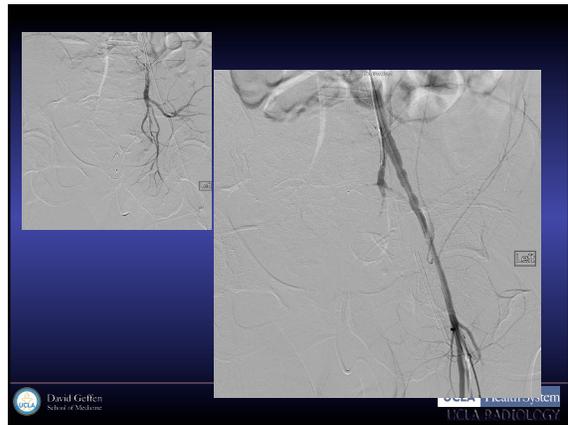
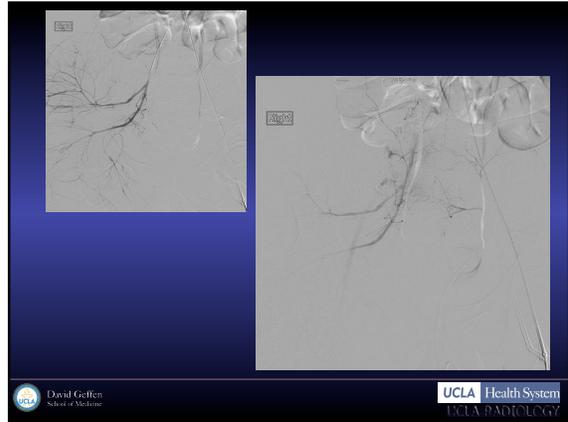
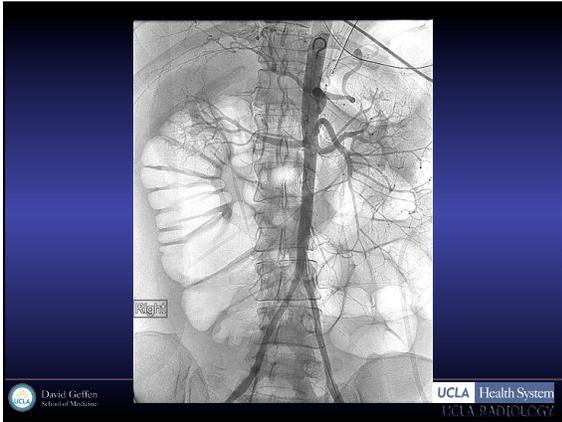
Catheter advanced to origin of right obturator artery. Gelfoam embolization performed. Postembolization angiography shows stasis of vessel.



Case #5 patient outcomes

- Following embolization procedure patient was felt to be stable enough for orthopedic intervention.
- Patient received ORIF of SI joint injury, right patella fracture and multiple ORIF of right acetabular fracture.
- Tolerated procedures well, discharged on post-operative day 15.

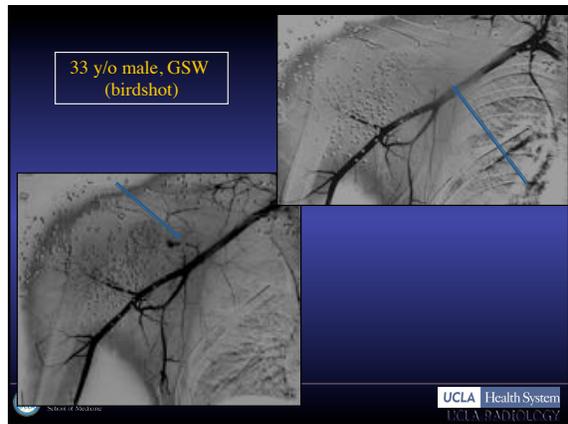
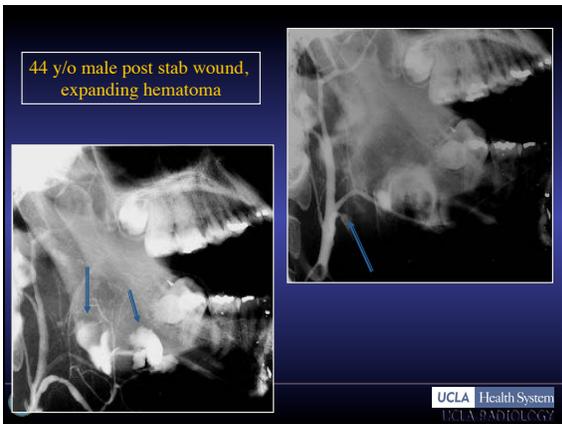
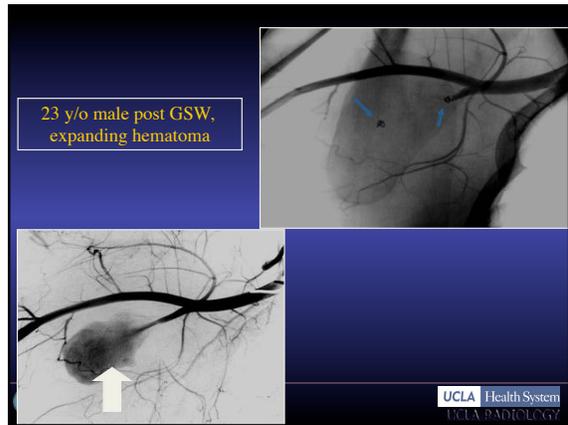
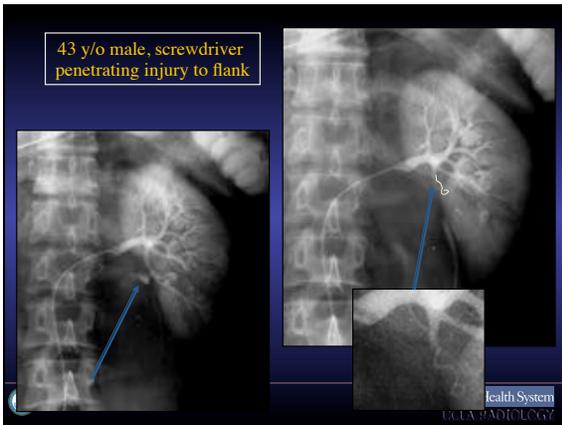




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Worst case

- Massive MVA
- No time for CT, extravasation from multiple pelvic abrasions, possible Splenic trauma
- Taken to OR for Peek and Shreek
- No abdominal extravasation, however, obvious pelvic hematomas, transferred to IR
- Multiple torn vessels, complete avulsion of Right IIA

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