NONVASCULAR INTERVENTIONAL RADIOLOGY (IR) OF THE ABDOMEN

Percutaneous radiological guided minimally-invasive image-guided procedures are effective alternatives in the treatment of a variety of abdominal disorders.
Interventional radiologists obtain images which are then used to direct interventional instruments throughout the body.
Many conditions that once required surgery can be treated non-surgically by interventional radiologists.
THE CONCEPT BEHIND INTERVENTIONAL RADIOLOGY is to diagnose and treat patients using the least invasive techniques currently available in order to:

- minimize risk to the patient and improve health outcomes
- minimizing the physical trauma to the patient
- reduce infection rates and recovery time

ADVANTAGES OF IR:

- offering curative therapy to some patients
- capability to perform bedside procedures
- reduction / elimination of the need for general anesthesia
- possibility of delaying surgery in critically ill patients until it is feasible

To continue to be on the forefront of innovation, interventional radiologists must possess:

- special training - - technical skill
- clinical knowledge - ability to care for patients
- closely collaborate with surgeons and internal medicine sub-specialists.

PRE-PROCEDURE:

The preprocedure evaluation assists procedure planning and risk assessment. Order extra exams when neseccarry.
THE INDICATION for the procedure is based on: knowledge of patients' symptoms / history (risk factors for abscess, recent surgery, infection or immunosuppression), etiology, previous images and lab status. (This may guide therapy. For example must infection with *Echinococcus* species be treated cautiously because of the risk of anaphylaxis).
LAB SAMPLES according to our local policy:

- Platelets ≥ 40 x 10^9/L
- Hb ≥ 8g/dL hematocrit
- INR<2
- ATTP <45 sec

Any coagulopathy should be considered corrected before the procedure (administration of platelet concentrate, fresh frozen plasma, red blood cells or vitamin K).
An intravenous line should be established before the procedure.

PROCEDURE

In general the procedures are done in local anesthesia, but the patient may be monitored by an anesthesiologist under intravenous sedation.
INTERVENTIONAL IMAGING MODALITIES
Guiding modality for IR is chosen on "what" and "where" to treat, organ size, personal preference of the interventional radiologist and appearance on the previous images in the different modalities (Fluoroscopy / CT / Ultrasound / MR).

• **Fluoroscopy** and computed tomography have the advantages of being fast and geometrically accurate. **Multislice CT** imaging with GI preparation and intravenous contrast media are helpful tools.
• **Ultrasound** is frequently used to guide needles during procedures. Ultrasound is multiplanar, offers real-time feedback and is inexpensive. Ultrasound suffers from limited penetration and difficulty visualizing needles, catheters and guidewires.
Eventually supplementary contrast enhanced ultrasound (CEUS) and "GPS" guiding tools makes ultrasound attractive these days.
• **Magnetic resonance imaging** (MRI) provides superior tissue contrast, but is expensive and requiring specialized instruments.
Delayed imaging with additional oral contrast preparation may be considered in challenging cases. (Identifying ureter in the excretory phase).
Consider hydro dissection (CT-guided injection of 0.9% saline solution for displacing vital structures and creating a percutaneous access route) or CO2 insufflations for protecting nearby organs.
SELDINGER / TROCAR:
Drain insertions is the placement of tubes into different parts of the body to drain fluids (e.g., abscess drains to remove pus, pleural drains). Careful attention should be paid to ensuring that the side holes are completely within the abscess cavity and that the abscess cavity is completely evacuated.
Many drainage catheters come with the option of being deployed as a trocar by putting in an inner stylet. **Trocar** technique should mainly be used only for percutaneous drainage of collections of fluid (ascites / pleura effusion).
Seldinger technique is a puncture with a sharp, hollow needle (trocar) in the desired cavity. A guidewire is then advanced through the lumen of the trocar, and the trocar is withdrawn. A drainage tube is passed over the guidewire. After passing a sheath or tube, the guidewire is withdrawn.

POST-PROCEDURE:
After complex / long-lasting IR assisted by an anesthesiologist under intravenous sedation, the patient will be observed for 2 hours at intensive care unit.
Prophylactic antibiotics should be considered will be started if procedural time exceeds 3 hours (especially after liver interventions).
Suggest follow-up examinations if necessary to evaluate response to procedure / treatment (an abscessogram obtained fluoroscopic, with ultrasound or CT is used to evaluate the reduction in size of the abscess cavity and any possible fistula formation).

INTERVENTIONAL RADIOLOGY IN THE ABDOMEN
I. PERCUTANEOUS BIOPSY
II. PERCUTANEOUS ABSCESS DRAINAGE (PAD) / DRAINAGE OF COLLECTIONS OF FLUID
III. PERCUTANEOUS URINARY INTERVENTIONS
IV. BILIARY INTERVENTIONS
V. ONCOLOGIC

I. PERCUTANEOUS BIOPSY
Samples of tissue may be required to identify the cause of certain diseases. Using imaging guidance, interventional radiologists may minimally-invasively reach underlying tissue using a small needle to pierce the skin and retrieve tissue samples from the target organ (percutaneous or transjugular approach).
For microbiological diagnosis: if no significant fluid can be aspirated, consider biopsy.

II. PERCUTANEOUS ABSCESS DRAINAGE (PAD) / DRAINAGE OF COLLECTIONS OF FLUID

PAD is generally a safe and effective treatment and the standard therapy for postoperative abdominal abscesses.
Routine procedure, replacing open surgical abscess drainage in all but the most difficult or inaccessible cases.
INFECTED TISSUE
Serious local infection can be categorized by location, viscosity, complexity, contents, etiology, or surrounding structures. It can occur in solid organs (eg, liver, muscle), potential spaces (eg, pleural or peritoneal cavity), or in preexisting or physiologic fluid collections or organs (eg, gallbladder, urinary tracts).
DD to abscesses: Hemangioma, necrotic malignancy, hematoma, necrosis or lymphadenitis.
PREPROCEDURE EVALUATION of CT and US are excellent at identifying potential abscess areas.
Abcesses do not demonstrate central enhancement on imaging studies. Additional MRI (most useful in the musculoskeletal system - intraosseous and subperiosteal abscesses).
In the proper clinical setting, strong signs are a well-circumscribed fluid collection, thickened membranes or septations, gas bubbles, peripheral contrast enhancement, and debris.
Weaker signs are nonloculated or thin-walled nonenhancing collections that have alternative pathophysiologic explanations, such as peritoneal or pleural fluid.
A phlegmon may be defined as a vascularized infection that still has perfusion (undrainable infection).
Differentiating bowel from pathologic intra-abdominal fluid collections is important. (This may be difficult in patients with scant body fat, postsurgical abdomen, or unopacified bowel loops).
VISCOSITY AND COMPLEXITY (septation, loculation, and debris) are difficult to assess with imaging alone. Viscosity ranges from that of near water to near solid and cannot be readily predicted unless debris or suspended bubbles are seen. Abscess complexity ranges from unilocular to innumerable septations and loculations. (Fine septations are easily missed on CT scans because of partial volume averaging on routine scans).
WHAT CAN BE TREATET?
Main determinants of ease of drainage are viscosity and complexity. The simpler the abscess, the more likely PAD will be rapidly successful.
Both septated and viscous fluid collections may be successfully treated percutaneously, particularly with the adjunctive use of lytic agents. (Thrombolytics may disrupt fibrin and bacterial cell structures - urokinase, tissue plasminogen activator [t-PA]).
Viscous collections require larger diameter catheters and more aggressive flushing and may require multiple catheters. Septations may be disrupted with a guidewire maceration technique. An aggressive practical approach with relatively simple devices and techniques may yield a high success rate with few complications.
Viscous or debris-laden fluid requires larger diameter catheters: 10-14F for complex abscesses and 24-30F for severe pancreatic necrosis (multiple catheters may be necessary). Typical examples of complex viscous abscesses include infected pancreatic abscesses or infected retroperitoneal hematomas. These processes are challenging to treat percutaneously and may require multiple interventions over a prolonged recovery period.
Routs to the pancreatic bed. Illustration.
NEEDLE CHOICE
A viscous abscess (significant with debris, blood, or viscous elements) may be difficult to aspirate through a needle but should be drainable through catheters of appropriate caliber.
(Irrigation with saline or fibrinolytic agents may be necessary for successful drainage).
Typical abscess fluid is readily aspirated through an 18-gauge needle.
COMMERCIAL DRAINAGE CATHETERS come in a wide variety of sizes and materials. Factors to evaluate are cost, comfort, flexibility, ease of tracking (ability to follow guidewire), kink resistance,

inner diameter, side-hole diameter, durability, tip configuration, securing mechanism, and catheter coating.

THE DRAINAGE CATHETER'S EFFECTIVENESS is determined chiefly by its inner diameter and kink resistance. Determine the catheter choice with the needle aspiration test (NAT). If the fluid can be easily aspirated (1 mL in 1 second) by a 10-mL syringe through an 18-gauge needle, then the abscess is drained with the 8.5F catheter.

POST-INTERVENTIONAL TO PAD:

Drainage time from 1 week to months. Abscesses associated with a perforated bowel (high- and low-flow fistulas) are also challenging to treat.

The presence of a **fistula** increases the duration of catheter use.

Post-PAD problems (25 %) are catheter dislodgement / accidental removal, catheter obstruction, to small catheter-diameter and kinking of the catheter. Careful attention must be paid to securing the catheters.

Drainage bags are often left "alone" and not inspected / flushed by saline.

I prefer not to use a drainage bag in abscesses (unless high out-put is expected).

I believe catheter dislodgement will occur less often and that the nursing shifts will pay more attention to the catheters this way. Successful treatment requires the understanding and cooperation of the patient and referring physician.

Adjust the volume and frequency of catheter flush based on cavity size, drainage quality, and quantity. The catheter is flushed at least once per nursing shift of normal saline.

Most of post-PAD problems can be managed by exchange, revision, or increase in size of the catheter.

REMOVAL OF CATHETER:

When clinical, laboratory, and radiologic improvement is observed, and the amount of daily drainage is less than 10 mL/24 h. If the catheter is withdrawn over a guidewire under fluoroscopic guidance there will be access in case of bleeding.

Darinage of **deep pelvic abscesses** may present a unique challenge for percutaneous drainage because of numerous overlying structures (pelvic bones, intestine, bladder, iliac vessels, and gynecologic organs).

Use of the transgluteal approach: insert the catheter as close to the sacrum as possible, at the level of the sacrospinous ligament if possible belove the level of musculus piriformis. (Alternatives transvaginal / transrectal).

(Percutaneous drainage by using the surgical drain as an access route is an alternative for draining postoperative abdominal abscesses that are less accessible with direct puncture).

If there is any suspicion about catheter patency and fistula, the patient should be examined in the interventional radiology unit.

III. PERCUTANEOUS URINARY INTERVENTIONS

Nephrostomy placement:

In conditions where normal flow of urine is obstructed between the kidney and the urethra (such as with kidney stones), a catheter may be placed into the kidney under imaging guidance to allow the drainage of urine and to prevent kidney damage. Nephroureteral stents can be placed through the ureter and into the bladder.

IV. BILIARY INTERVENTION:

Interventional radiologists commonly perform procedures such as **percutaneous transhepatic cholangiography (PTHC or PTC)** to image obstructions, and may treat these conditions using percutaneous transhepatic biliary drainage (PTBD) (**catheters / stents** placement for prolonged periods of time or until surgery).

PTBD should be considered the treatment of choice in patients with benign anastomotic stricture after bilioenterostomy, especially after stricturing of a hepatojejunostomy.
The "rendezvous procedure" combines percutaneous transhepatic and endoscopic retrograde cholangiography. It enables positioning of the internal drain. A steel guide protected by a plastic catheter is advanced transhepatically into the duodenum.
Because percutaneous transhepatic interventions often are long-lasting, consider 2 sessions. Always consider monitoring by an anesthesiologist under intravenous sedation.

Cholecystostomy:

Placement of a tube into the gallbladder to remove infected bile in patients with cholecystitis, an inflammation of the gallbladder, who are too fragil or patient to sick to undergo surgery.

V. ONCOLOGIC

Various interventional therapies exist to treat cancers. **Transarterial chemoembolization**, block the blood supply to tumors.
Percutaneous ablation (radiofrequency ablation (RFA) / microwave ablation /cryoablation, irreversible electroporation (IRE) / and high-intensity focused ultrasound (HIFU)) directly damage the cancerous tissue by localized destruction of tissue.
Palliative oncological care**:** percutaneous nephrostomy, percutaneous biliary drainage **plexus blocks** and ablations.
Neurolytic celiac plexus block: Poterior percutananeous CT-guided delivery of local anesthetics and neurolytig agents (alcohol or phenol) antecrural at the plexus coeliacus.

RADIOLOGICAL POSTINTERVENTIONAL COMPLICATIONS

Any unfavourable and unintended sign, symptom, or disease temporally associated with the treatment.
If major complications are expected or suspected diagnostic imaging should be done urgent or surgery.

- PAIN
- PERFORATION
- INFECTION
- VASCULAR (BLEEDING) AND BILIARY INJURY
- DEATH

Complications treated as follows:
Peritoneal bleeding can be treated with blood transfusions and / or transarterial embolization
Infections is treated with administration of antibiotics (PAD?) and observation.

CONCLUSION:

The least invasive or expensive treatment that is effective should be chosen to treat a complication. The concept behind interventional radiology is to diagnose and treat patients using the least invasive techniques available in order to:

- MINIMIZE RISK
- IMPROVE OUTCOMES

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