Iatrogenic complications after abdomino-pelvic procedures - a pictorial review

Poster No.: C-2501
Congress: ECR 2017
Type: Educational Exhibit
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Keywords: Acute, Surgery, Complications, MR, CT, Abdomen
DOI: 10.1594/ecr2017/C-2501

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**Learning objectives**

It is important to be aware of the main abdominal and pelvic iatrogenic injuries following non-open surgery interventions.

Correct diagnosis requires knowledge of the patient's symptoms and signs related to each complication, and choosing the adequate imaging modality available for the suspected condition.

Rather than demonstrating an exhaustive review of every potential complication, this presentation aims at showing common procedures in a hospital environment and relevant iatrogenic complications, thus raising awareness for radiologists in what to look for in such cases.
Background

Iatrogenesis is a greek term that encompasses any consequence of medical treatment. This presentation focuses on consequences of commonly performed minimally invasive abdomino-pelvic interventions, which include:

- Drainage catheter placement
- Tumor Ablations
- Screening techniques
- Laparoscopic/Minimally-invasive procedures
- Embolization interventions
- Fluoroscopy procedures
- Endovascular procedures
- Radiotherapy, lithotripsy and others

Several iatrogenic injuries may occur during the above-mentioned procedures and its frequency is heavily dependent on the operator’s experience. They can be categorized in either vascular or non-vascular injuries.

These conditions may severely compromise patient outcome, and radiologists have to be aware and search for possible iatrogenic causes when performing diagnostic imaging.

Intubation /catheterization:

Tube feeding is considered a fairly safe and efficient procedure, extremely useful for alimentation in selected patients and technically straightforward. However, several complications have been reported in the literature, such as tracheal-bronchial misplacement, pneumothorax, esophageal rupture / laceration and, in cases of difficult intubation, gastric rupture.

In situations of difficult airway management, not only hollow viscera rupture is more prevalent, but it may also lead to massive intraperitoneal air with development of tension pneumoperitoneum. Which requires immediate intervention.

Furthermore, urinary catheterization, a commonly employed procedure in hospital practice, may also be subject to distinct complications, namely:

- Trauma (urethral, bladder or ureter)
- Hematuria (micro/macroscopic)
- Infection (urinary tract, genital)
- Stricture formation
- Chronic inflammation and increased risk of cancer
Biopsy, drainage and other non-vascular interventional techniques

There are innumerable non-vascular interventional techniques described in the literature and this topic is in constant innovation and expansion. Despite its widespread use in oncology for therapeutic purposes, interventional techniques are also effective in benign conditions. These techniques include: tumor ablation, biliary and collection drainage, placement of feeding tubes (e.g. gastrostomy), percutaneous nephrolithotomy, among others.

There are some general principles that one must be familiar with before taking part in the practice of nonvascular intervention: patient selection, medication (analgesia, antibiotics, other), hemostasis, bleeding risk factors, other diagnostic and therapeutic options, complications and management. When complications are not timely managed and taken care of, radiologic examinations might be necessary, which gives the radiologist the need to assess for the following complications:

1. **Bleeding** - active hemorrhage, likely site and amount of bleeding are relevant for the clinician
2. **Infection** - abscess formation or diffuse affliction of an organ/structure (e.g. cholangitis)
3. **Unintended transgression of organ** - although several organs tolerate puncture, bowel transgression may lead to rupture and eventual peritonitis; the liver, spleen and kidney are likely to bleed and should be assessed with care.

Laparoscopy procedures

Laparoscopic surgery has evolved over the last decades and is now accepted as a first choice method for treatment of several conditions. However, in some instances such as gynecological surgery, the risk of major complications has proved to be similar to open surgery, and they also have specific complications that cannot be ignored.

Different surgeries encompass distinct complications, which are dependent of patient factors (organ /regional inflammation, anatomic variants, other) and the surgeon’s experience. The main laparoscopic surgery indications for abdomino-pelvic treatment and their complications are as follows:
• Cholecystectomy - major bile duct injury (misidentification of the common bile duct or common hepatic duct for the cystic duct) with or without devascularization; delayed stricture due to thermal injury
• Anti-reflux surgery - stomach or esophagus perforation, splenectomy, pneumothorax, para-esophageal herniation, atelectasis, pneumonia
• Inguinal hernia repair - recurrence, port site herniation, hematoma/seroma, neuralgia, mesh infection
• Appendectomy - intra-abdominal abscess /infection
• Colectomy - enterotomy, mesenteric bleeding and ureteric injury

For gynecological laparoscopic surgery, the most common complications are separated in the following categories:

• Vascular injuries - frequently occur during initiation of pneumoperitoneum and, less commonly, when a trocar is inserted; major vessels such as the distal aorta and right common iliac artery are prone to injury; the most commonly affected minor vessels are the inferior epigastric vessels
• Bowel injuries - generally occur during insertion of the Veress needle (for insufflation), the primary or secondary trocar
• Urological injuries - most common during hysterectomy, but also present in urinary stress incontinence and / or genital prolapse procedures, and severe endometriosis resection

Endoscopic procedures

Upper GI endoscopy is a safe procedure, with an estimated rate of complications of 0.13% and associated mortality of 0.004%. Therapeutic techniques have increased in demand and diversity, and include esophageal dilatation and stent placement, hemostatic techniques, polypectomy, endoscopic mucosal resection, ablative techniques and removal of foreign bodies. Major complications include:

• Cardiorespiratory - related to sedation and analgesia
• Infection - bacteremia; aspiration pneumonia; abscesses are rare and presumed to be a result of occult perforation
• Bleeding - rare complication, even in cases of mucosal biopsy, in the absence of susceptibility (coagulopathy, portal hypertension or other); gastric bleeding is more frequent than esophageal
• Perforation - uncommon event (frequency of 0.03%) that may occur in the pharynx and esophagus, where passage of the endoscope is passed blindly or at sites with disease

The incidence of complications of colonoscopy varies widely in the literature, due to lack of prospective studies and standardization. Mortality rates are considered low (0.07% on a 30-day mortality prospective study in the UK). Diagnostic or therapeutic techniques employed during the examination as well as insertion of the device may pose some complications, such as:
• **Cardiovascular** - increase in sympathetic tone can lead to arrhythmia, hypertension and ST changes

• **Pain reaction** - while discomfort is normal, pain should alert the practitioner for possible loop formation or excessive air insufflation (limits of the organ accommodation of the device and significant wall stretching)

• **Colonic perforation**

• **Bleeding**

• **Rare complications** - glutaraldehyde-induced colitis, colonoscope incarceration in an hernia, splenic rupture, liver or mesentery hemorrhage, volvulus, pneumatic ileal perforation, pneumatosisis coli, pneumomediastinum, pneumothorax

Endoscopic retrograde cholangiopancreatography (ERCP) is the most complicated endoscopic procedure performed by gastroenterologists and has a steep learning curve. Selection of patients that could really benefit from ERCP is crucial in avoiding complications, since the patients that need ERCP the least are the most likely to develop complications.

The overall incidence of complications after sphincterotomy is 5%, 20% of which are severe. Mortality rates are around 0,2% in latest series. The commonest cause of procedural death is cardiopulmonary.

Bleeding is uncommon during ERCP and its virtually unique cause is sphincterotomy.

There are 3 types of perforation after ERCP, namely:

1. **Retroperitoneal duodenal perforation** - most commonly seen, usually follows an extended sphinterotomy
2. **Perforation of the bile ducts** - occurs following dilatation of biliary strictures, inadvertent portal cannulation and insertion of guide wires
3. **Free abdominal perforation of the duodenum and jejunum** - rare, generally occurs in the setting of abnormal anatomy (variants, post-surgical)

• **Other** - gastric or esophageal perforation, pneumomediastinum

Endoscopic urology procedures are considered first-line options for the treatment of benign prostatic obstruction, stone disease, and non-muscle-invasive urothelial tumours. They are associated with favorable results but, nonetheless, may have some post-operative and acute complications that have to be identified and reported.

Transurethral procedures may lead to the following post-operative and acute complications:

• **Bleeding** - rare in the perioperative stage, it is most common in the early post-operative
• Prostatic capsular perforation
• Urinary tract infections - early post-operative stage
• Acute urinary retention - mostly due to clot retention, requires re-catheterization

Long-term complications, such as bladder neck and urethral strictures, and sexual dysfunction are beyond the scope of this presentation.

The most common immediate complications after bladder endoscopic surgery for bladder tumor are: perioperative severe bleeding (2-13%), intraperitoneal-extra-peritoneal bladder perforation (3-5%) and urinary tract infection (3%). Other less common complications are: injury and stenosis of the urethral orifices, secondary urethral stenosis, post-operative fistula, bladder explosion, resorption syndrome and false passage.

Retrograde ureteroscopy is widely used for stone disease, minimally invasive treatment of upper tract urothelial carcinoma and ureteral strictures. The most frequent complications are fever (2-28%), sepsis (3-5%), bleeding (5%) and ureteral injury (1%). Rare complications include: severe ureteral damage and avulsion, ureteral strictures, kidney damage, severe bleeding with transfusion and fistulas.

The images below show the main complications and their sites of occurrence.
**Fig. 1:** Image belongs to Cornu JN, Herrmann T, Traxer O, Matlaga B. Prevention and management following complications from endourology procedures. European urology focus 2 (2016) 49-56

**References:** Cornu JN, Herrmann T, Traxer O, Matlaga B. European urology focus 2 (2016) 49-56

**Vascular intervention**

Angiography and vascular intervention techniques are included in this presentation since they may be routinely performed in a Radiology Department. In his or her professional
activity, a diagnostic radiologist might be faced with examinations of patients that have been subjected to transarterial chemoembolization (TACE) for malignancies, angioplasty for arterial stenosis, vessel embolization due to haemorrhage or varicose veins, and a wide range of other highly effective and selective treatments that, nevertheless, pose some risk of specific adverse events.

Complications might occur at the site of puncture, which include bleeding, hematoma, pseudoaneurysm or arterio-venous fistula formation and vessel occlusion. Other complications during procedure include non-target embolization with/without organ failure, infection (organic and/or systemic), bleeding, dissection and post-embolization syndrome.

Other - radiation therapy, shock wave lithotripsy:

External oncologic radiotherapy has evolved in the last decades and is has established itself as a useful technique for treatment of some tumor types at specific stages of disease. Although current methods of delivering radiation have an extraordinary geographic precision, adjacent tissues and organs do suffer changes that can be visualized in radiological exams.

It is known that the most sensitive tissues are those that have a high regeneration (turnover) rate and thus the intestinal crypt cells, epidermal basal cells, staminal cells and erythroblasts are particularly susceptible.

The spleen, kidneys, pancreas and liver might suffer changes due to undesired radiation, which promotes tissue necrosis, atrophy and calcification with loss of function (depending on the parenchymal extension). These changes can mimic other organic insults and clinical history as well as geographic pattern recognition guides diagnosis. Although the excretory system appears to be extremely radiosensitive, ureters are fairly resistant to changes induced by radiation, which can promote strictures as a form of late complication. The bladder, on the other hand, is frequently affected by pelvic irradiation (12% cases) and findings such as wall thickening and hyper-enhancement are not uncommon. They are, nonetheless, unspecific and prompt endoscopic evaluation for cystopathy.

The gastointestinal system shows distinct sensibility rates and the most radiosensitive is indeed the small bowel, due to the high turnover of its mucosal layer. The rectum is the most resistant segment, however due to its fixed location and proximity to organs that are commonly irradiated, it is subjected to significant amounts of radiation. Acute complications of enteropathy manifest clinically as diarrhea, malabsorptio, functional/structural abnormalities. Chronic enteropathy courses with strictures and obstruction, transmural compromisse, fibrosis and fistula formation.
The ovaries are very radiosensitive and the normal depletion of follicles is hastened by radiation therapy in pre-menopausal women. The glandular elements of the uterus also atrophy and diminish in size with exposure to radiation. This loss of organ volume and atrophy is also evident in male pelvic organs, such as the prostate, seminal vesicles and testis.

Shock wave lithotripsy (SWL) is a non-invasive method that uses sound waves to fragment calculi and is a treatment of choice for some urinary stones and has excellent outcomes depending on their size, morphologic properties and location. Acute renal injury, especially hemorrhage, is the most common complication from this procedure, with a great dispersion (1-30%) incidence in the literature. Damage to almost every abdominal organ is also reported in the literature.

Gross hematuria invariably follows SWL and failure of this occurrence indirectly suggests incorrect shock wave delivery. Worsening of otherwise normal flank pain should also prompt investigation for a potential complication.
Findings and procedure details

Retrospective evaluation of patients that underwent diagnostic and therapeutic radiologic procedures following non-open surgical interventions and had findings which confirmed or were highly probable of iatrogenic complication.

Patient sample was obtained through systematic search of the Radiology Department database from our institution.

INTUBATION / CATHETERIZATION

Ureter perforation during bladder catheterisation

This patient was sent to the hospital emergency ward from a nursing home due to frank hematuria and pain post-bladder catheterisation.

Retrograde opacification of the excretory system was performed, followed by an abdominal CT. Selected images show opacification of the left ureter, with diffuse wall thickening and anterior discontinuity along the middle third (arrows), with extravasation of contrast to the retroperitoneal space (asterisks). Located posteriorly to the distal segment of the left ureter, there is accumulation of liquid compatible with urinoma.

The findings were suggestive of traumatic catheterisation.
Fig. 3: Ureter traumatic perforation. A - below perforation level. B - at perforation level C - above perforation level. D - Oblique coronal reconstruction.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 4: MIP reconstruction.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Traumatic nasogastric intubation

46 year old patient, with respiratory exhaustion in need of mechanical ventilation, was intubated with a nasogastric probe. Abdominal x-ray shows a large pneumoperitoneum. Abdominal CT was performed which showed abdominal gas (arrows) trapped at the lesser gastric curvature and along the distal esophagus. Traumatic perforation during intubation was the most likely mechanism.
Fig. 5: A, B - axial and C - coronal oblique CT images.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Renal biopsy complicated with hematoma

36 year old woman subjected to a ultrasound-guided renal biopsy for characterisation of suspected parenchymal disease. During the procedure, the patient complains of progressive severe pain at the puncture site that intensifies. Ultrasound examination showed a peri-renal haematoma (asterisk), that was better characterised with CT. The haematoma extends beyond the renal capsule along the surrounding fascia, into the left lower flank. The kidney contour is highlighted by arrows.
Fig. 6: Ultrasound examination during biopsy shows a hyperecogenic area surrounding the kidney.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 7: A, B, C - Axial CT images performed immediately after the ultrasound examination, showing hyperdense tissue (asterisk) surrounding the left kidney (arrows), compatible with perirenal hematoma.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 8: A - sagital, and B - coronal reconstructions.

**References:** Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

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**BIOPSY, DRAINAGE AND OTHER NON-VASCULAR INTERVENTIONAL PROCEDURES**

**Transplant kidney biopsy complicated with fistula**

Biopsy performed on a transplant kidney with signs of graft rejection. Some hours after the procedure, there is evidence of hematuria which is resolved on the following day. Ultrasound performed 3 days later reveals an arterial-venous fistula on the puncture site (lower third). Findings include turbulent flow, increased peak systolic velocity (250 cm/s), increased end dyastolic velocity and reduced resistive index (0.45). Arterialization of the venous waveform is also evident.

The incidence of post-biopsy transplant kidney fistulas is high (15%) and the majority resolves some months afterwards (80%). however, care should betaken, since these
fistulas may be responsible for hemorrhagic events and hypertension and deterioration of renal function.

**Fig. 9**: Doppler ultrasound of the kidney transplant.

**References**: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

**Liver biopsy complicated with fistula**

30 year old man, with cryptogenic cirrhosis and a non-characteristic nodule, subjected to a blind liver biopsy. Several weeks after the biopsy, the patient performed an abdominal CT for screening of hepatocarcinoma.

On the arterial phase, there is a fistulous tract that is suggestive of a post-biopsy fistula (arrows). Segment 7, which is located close to the fistula, has an heterogenous enhancement, although no washout is seen. Differential diagnosis includes an arteriovenous fistula due to cirrhosis alone, although its extent and linear tract are unusual.
Liver biopsy complicated with hematoma

Patient with cryptogenic cyrrhosis subjected to blind liver biopsy, had a sudden drop of haemoglobin from 10 g/dl to 5 g/dl. A large pericapsular and peritoneal haematoma is shown (asterisk), although no active haemmorhage is detected.
Fig. 11: A, B - portal-phase CT. C - Coronal reconstruction.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Nephrolithotomy complicated with renal infarct and hemorrhage

Elective nephrolithotomy complicated with hemorrhagic shock. Laboratory analysis revealed worsening of renal function with metabolic acidosis and drop in hemoglobin levels. The left kidney shows a hypoperfused area on the middle and lower third, compatible with renal parenchymal infarct (asterisks). There is peri-renal and retroperitoneal fluid with high density, suggestive of hemorrhage.
Fig. 12: A, B - axial abdominal and pelvic CT, C - coronal and D - sagital reconstruction images.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Intracolic nephrolithotomy tube

Percutaneous nephrolithotomy performed for the right and left kidneys due to prostate neoplasia with invasion of the bladder and distal ureters and consequent hydronephrosis. The nephrolithotomy catheters were not functioning and an ultrasound and CT were performed. The image below reveals that the right catheter is perforating the colon, a possible iatrogenic complication following drainage placement (unintended transgression of abdominal organ).
Fig. 13: Axial CT image with bone window showing trans-colic nephrolithotomy catheter.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

LAPAROSCOPIC PROCEDURES

Laparoscopic oophorectomy complicated with hemorrhage

Patient subjected to right oophorectomy and left ovarian lesion excision biopsy with a laparoscopic technique. Sudden drop of haemoglobin levels on routine examinations during recovery prompted performance of abdominal CT, which revealed frank intra-abdominal hematoma with foci of active hemorrhage. Due to its location and the technique performed, the most likely vessel involved is the right inferior epigastric artery.
Fig. 14: A, B, C - portal-phase CT performed after laparoscopic surgery shows a frank haemorrhagic collection in the lower peritoneal recesses (asterisk). There is a hyperdense area within the collection (arrows) that is highly suggestive of active haemorrhage.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Perforation and abscess following laparoscopic Nissen fundoplication

Nissen fundoplication performed to a patient with refractory esophageal reflux disease and sliding hiatal hernia. There is a fluid collection in the right mediastinum with gas in its interior, adjacent to the esophagus, which shows diffuse wall thickening (A - arrow).
The proximal esophagus is dilated and shown in the coronal reconstruction (C - arrow). There is also pulmonary consolidation at the right lower lobe seen in the images below.

These findings were highly suggestive of contained perforation of the esophagus complicated with mediastinum abscess.

Fig. 15: A, B axial CT and C - coronal reconstruction images

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Post-laparoscopic cholecystectomy haematoma

90 year old woman was subject to laparoscopic cholecystectomy. During ward passing rounds an abdominal wall hematoma was noted. A frank intra-abdominal haematoma was confirmed (asterisks).
Fig. 16: A, B, C - axial CT images performed post-operatively. D - sagital reconstruction.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Portal incision hernia incarceration post-bariatric surgery

62 year woman subjected to laparoscopic bypass surgery 3 days before, presents with severe abdominal distension, pain and food intolerance. Abdominal CT showed small bowel incarceration at the porta incision, with significant dilatation upstream of the obstruction, which was confirmed peri-operatively.
Fig. 17: A, B - axial CT images performed 3 days after bariatric surgery show hernia incarceration at the portal incision (arrows) and significant bowel dilatation.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

ENDOSCOPIC PROCEDURES

Videocapsule entrapped at the terminal ileum

A 56 year old patient had swallowed a videocapsule 15 days before the examination, but it still hadn't come out. CT showed that the videocapsule was entrapped at the distal ileon (arrows). However no signs of obstruction or local compromise were found. A colonoscopy was performed afterwards to retrieve the videocapsule, with no sucess. The report revealed ulceration of the ileal mucosa, which was biopsed and was found to be unrelated to a suspected inflammatory bowel disease.
Fig. 18: A, B - coronal reconstructions and, C - axial CT image showing the videocapsule at the terminal ileum (arrows).

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Post-UGI endoscopy abscess

This patient performed an upper GI endoscopy for persistent upper abdominal pain. The UGI endoscopy report described pyloric stenosis. Another UGI endoscopy was performed with the same result. Due to persistence of abdominal pain and distension
post-examination as well as pain on superficial palpation, an abdominal CT was performed.

Multiple abdominal collections are shown, involving the pylorus, the antrum and the gastric curvature as well as the subfrenic space (asterisks), with wall enhancement. The pylorus shows irregular thickening (arrows). These findings are suggestive of post-UGI endoscopy abscesses, possibly due to forcing of a stenotic area.

**Fig. 19**: A, B, C - axial post-contrast portal-phase CT images. D, E - coronal oblique reconstructions.

**References**: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Post-ERCP perforation

63 year old woman that was undergoing ERCP. Post-sphincterotomy, the gastroenterologist suspects of bowel perforation. Abdominal CT performed peri-operatively reveals a pneumo-retroperitoneum that extends along the pararenal and peri-renal space, upwardly to the peri-frenic space and anteriorly to the porta hepatis.

This is suggestive of the most common perforation complication of ERCP and can be treated conservately.

Fig. 20

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Ureter perforation during transurethral ureteral cystoscopy
Trans-urethral removal of calculus that was obstructing the urether. Description of the procedure reveals a tortuous ureter with identification of an obstructive calculus at the iliac crossover. Laser lithotripsy damaged the ureteral mucosa and attempts to place a guide wire perforate the ureter with insertion along false tract and extravasation of contrast. Attempts to perform an anterograde ureteral catheterisation with ultrasound-guided renal puncture are unsuccessful and reveal extravasation of contrast at the iliac crossover.

Abdominal and pelvic CT was performed to assess extent of complications. There are several gas bubbles in the retroperitoneum along the right ureteral tract (arrows), along with peri-ureteral fat stranding and diffuse ureteral wall thickening (arrow-heads). On excretory-phase CT, there is poor opacification of the right ureteral lumen.

**Fig. 21**: A, B - axial CT and C - coronal reconstruction images.

**References**: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Abdominal and pelvic CT performed several weeks after discharge reveals a near-normal excretory phase with evident lumen opacification. There is still some peri-ureteral fat stranding, although the wall is not thickened.
Fig. 22: A - axial pelvic CT and B - coronal abdominal and pelvic reconstruction images.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

VASCULAR INTERVENTION

Hematoma post-thermal ablation

Post-microwave thermal ablation (for liver metastasis) control CT shows capsular liver hematoma. In this case, the hematoma is small and there is no evidence of active hemorrhage, representing a mild complication with no significant clinical repercussion.
Fig. 23: A, B - axial post-contrast portal-phase CT images show subcapsular liver hematoma (arrows).

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Angiography complicated with puncture site haemorrhage

Sudden haemoglobin drop post-chemoembolization technique. An extensive hematoma is seen at the puncture site in the right inguinal region, extending along the ilio-psoas muscle (asterisks). Signs of active haemorrhage should be sought.
**Fig. 24**: A, B, C, D - Axial CT images show an extensive haemorrhage extending from the inguino-crural area anteriorly and superiorly adjacent to the ilio-psoas muscle (asterisks).

**References**: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

**Focal haemorrhage post-microwave thermoablation**

64 year old woman who performed a micro-wave thermo-ablation targeted at GIST metastasis located in segment 7. Adjacent to the necrotic area that is normally seen post-operatively (asterisk), there is a slightly hyperdense lesion that is suggestive of a small haematoma (arrow). There is no evidence of active hemorrhage.

**Fig. 25**

**References**: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

**Abscess post-thermoablation technique**

Patient with hepatocarcinoma in segment 7. Post-microwave thermoablation control CT shows a round area of necrotic tissue where the tumor was located, a normal post-operative finding.

However, 1 month later, the necrotic area not only doesn’t show size reduction but also shows peripheral enhancement, which was regarded as normal tissue response to treatment.

Two months later, the area has increased in volume, it is more heterogeneous and shows upward extension through the diaphragm into the pulmonary parenquima, showing
several cavitations with wall thickening. This is highly suggestive of a liver abscess, most likely due to the thermoablation therapy.

Fig. 26: Axial post-contrast portal-phase CT (A) immediately post-intervention and (B) 1 month later. Arrow points at the lesion.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 27: A, B, C - axial post-contrast portal-phase CT 2 months after the procedure. D - coronal reconstruction. Arrow points at the lesion, which is highly suggestive of a liver abscess.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Liver ischemia after hepatic chemoembolisation

Arterial chemo-embolisation performed in a 64 year old man with multiple foci of hepatocarcinoma. Apart from the treated necrotic areas (arrows), post-embolisation CT reveals delayed enhancement of the left lobe segments, where the lesion were located, compatible with liver ischemia. Several months later, control CT showed partial resolution of the ischemia insult.
Fig. 28: A, B - axial post-contrast porta-phase CT shows several hepatic lesions demonstrating washout, predominantly located in the left lobe (arrows).

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 29: Axial post-contrast portal-phase post-chemoembolisation CT shows necrotic areas (asterisks) corresponding to intervention sites. Furthermore, there are stark segmental perfusional changes affecting the left lobe, compatible with liver ischemia. The left portal vein was filiform (not shown).

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 30: Axial post-contrast portal-phase control CT some months after the procedure show partial recovery of perfusional pattern seen before chemoembolisation. Asterisk demonstrates the necrotic area.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

OTHER

Sigmoid stenosis after radiation therapy

75 year old man with an important sigmoid wall thickening, peri-colic fat stranding, with stenotic areas (arrows). There are also some segments of small bowel dilation, with no apparent obstruction. Note the remaining pelvic organs which are diffusely thickened.
Fig. 31: A, B, C - axial and D - sagittal abdominal CT images

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Recto-vesical fistula after radiation therapy

74 year old man with rectal cancer, subjected to rectal prosthesis, chemotherapy and radiotherapy, with suspected colo-vesical fistula. Transversal and sagital images reveal that the prosthesis bulges into the bladder through an extensive recto-vesical fistula. There is fecal matter inside the bladder and in the peri-rectal fat. The rectum has a diffuse
wall thickening, as well as the remaining pelvic organs and tissues. Although the nature of this fistula is multifactorial, radiotherapy surely played a role in its development.

Fig. 32: A, B - axial and C - sagital CT images.

References: Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT

Perforation post-radiation therapy

74 year old woman with uterine cancer, subjected to radiotherapy, complains of vomits and weight loss. Abdominal CT shows diffuse thickening and dilatation of the small bowel, without evident intrinsic or extrinsic obstruction. Three months later, she presents at the emergency department with signs of acute abdomen.

Abdominal TC demonstrates signs of bowel perforation with pneumoperitoneum, colon wall thickening, hyper-enhancement of the mucosa, peri-colic fat thickening and small bowel adhesions suggestive of post-radiation therapy inflammatory changes.
Surgery was performed with ileo-colical resection and sigmoidectomy.

**Fig. 33:** Axial CT images, months before the perforation event.

**References:** Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
**Fig. 34:** Axial CT images taken after gastrointestinal perforation.

**References:** Centro Hospitalar Lisboa Central, Hospital Curry Cabral - Lisbon/PT
Fig. 3: Ureter traumatic perforation. A - below perforation level. B - at perforation level C - above perforation level. D - Oblique coronal reconstruction.

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Fig. 6: Ultrasound examination during biopsy shows a hyperecogenic area surrounding the kidney.

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Fig. 7: A, B, C - Axial CT images performed immediately after the ultrasound examination, showing hyperdense tissue (asterisk) surrounding the left kidney (arrows), compatible with perirenal hematoma.
Fig. 8: A - sagital, and B - coronal reconstructions.

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Fig. 10: A - Pre-contrast, B - arterial-phase, C - portal-phase, D - delayed-phase CT.

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**Fig. 11:** A, B - portal-phase CT. C - Coronal reconstruction.

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Fig. 17: A, B - axial CT images performed 3 days after bariatric surgery show hernia incarceration at the portal incision (arrows) and significant bowel dilatation.

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Fig. 16: A, B, C - axial CT images performed post-operatively. D - sagittal reconstruction.

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Fig. 18: A, B - coronal reconstructions and, C - axial CT image showing the videocapsule at the terminal ileum (arrows).

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Fig. 19: A, B, C - axial post-contrast portal-phase CT images. D, E - coronal oblique reconstructions.

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**Fig. 23:** A, B - axial post-contrast portal-phase CT images show subcapsular liver hematoma (arrows).

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**Fig. 25**

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**Fig. 26:** Axial post-contrast portal-phase CT (A) immediately post-intervention and (B) 1 month later. Arrow points at the lesion.
**Fig. 27:** A, B, C - axial post-contrast portal-phase CT 2 months after the procedure. D - coronal reconstruction. Arrow points at the lesion, which is highly suggestive of a liver abscess.

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Fig. 31: A, B, C - axial and D - sagittal abdominal CT images

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Fig. 32: A, B - axial and C - sagittal CT images.

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Fig. 33: Axial CT images, months before the perforation event.

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**Fig. 34:** Axial CT images taken after gastrointestinal perforation.

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**Fig. 28:** A, B - axial post-contrast porta-phase CT shows several hepatic lesions demonstrating washout, predominantly located in the left lobe (arrows).

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Fig. 29: Axial post-contrast portal-phase post-chemoembolisation CT shows necrotic areas (asterisks) corresponding to intervention sites. Furthermore, there are stark segmental perfusional changes affecting the left lobe, compatible with liver ischemia. The left portal vein was filiform (not shown).

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Fig. 30: Axial post-contrast portal-phase control CT some months after the procedure show partial recovery of perfusional pattern seen before chemoembolisation. Asterisk demonstrates the necrotic area.

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Fig. 14: A, B, C - portal-phase CT performed after laparoscopic surgery shows a frank haemorrhagic collection in the lower peritoneal recesses (asterisk). There is a hyperdense area within the collection (arrows) that is highly suggestive of active haemorrhage.

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Fig. 35: A, B - axial abdominal and C - coronal thoracic and abdominal reconstruction images.

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Fig. 24: A, B, C, D - Axial CT images show an extensive haemorrhage extending from the inguino-crural area anteriorly and superiorly adjacent to the ilio-psoas muscle (asterisks).

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Conclusion

As minimally-invasive procedures have become more widely available, a variety of complications have also become more frequently encountered in common practice, especially since the advent of laparoscopy and vascular intervention.

Radiologists should be aware of the common findings post-procedure, the scope of complications that may arise, choose the appropriate radiological modality for its detection and promptly alert the clinician for findings that require treatment.
References

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