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PICTORIAL REVIEW

Learning the nodal stations in the abdomen

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ABSTRACT. The normal pathways of lymphatic drainage from the abdominal organs have been well described in the classic anatomy literature. Knowledge of the location and nomenclature of the common nodal stations in the abdomen are essential for complete report of radiological findings. CT is ubiquitous in the evaluation of oncology patients. Utilizing colour-coded CT images of the abdomen we will present the nomenclature and location of the nodal stations for common abdominal neoplasms, including those of the stomach, pancreas, liver, colon and the kidney. Understanding the nomenclature and the usual lymphatic pathways of metastasis will help radiologists detect disease spread from abdominal tumours. The goal of this pictorial review is to present the nodal stations, nomenclature and location of regional lymph nodes for the most common abdominal neoplasms. In addition, the reader can use this document as a handbook to learn and review this information.

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Radiology plays an essential role in the diagnosis, staging and surveillance of oncology patients. CT is the most commonly utilized imaging modality in the work up of these patients. During the review of the CT evaluation of the abdomen, radiologists often encounter lymph nodes (LNs; Figures 1–5). Correct localization of lymph nodes is critically important in tumour staging [1]. The identification of nodal stations together with an understanding of likely sites of disease dissemination

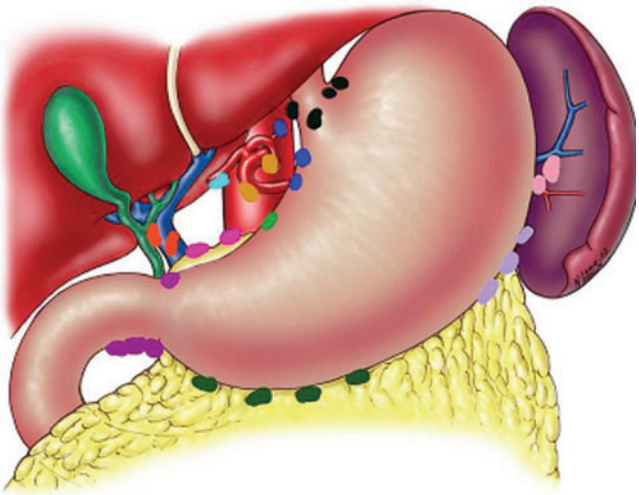

Figure 1. Diagram of the abdomen: gastro-oesophageal (black); hepatic artery (aqua); splenic (pink); gastro-omental (light purple); left gastric (blue); hepatoduodenal ligament (orange).

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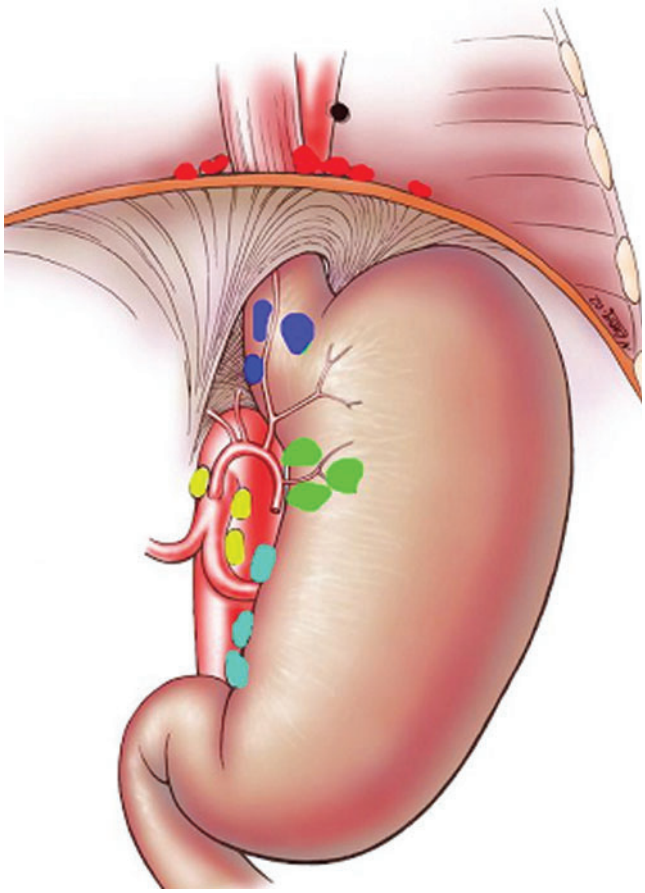

Figure 2. Diagram of the abdomen: left gastric (green); coeliac (yellow); diaphragmatic (red); paraoesophageal (blue); lesser curvature (aqua).

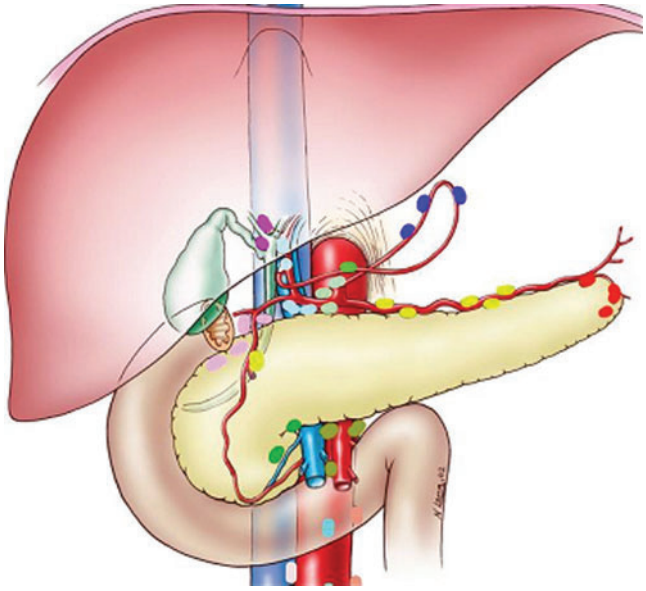

Figure 3. Diagram of the abdomen: coeliac (aqua); hepatic artery (light blue); left gastric (blue); gastroduodenal (pink); superior mesenteric (dark and light green).

becomes critical in the assessment of the probability that a detected lymph node is metastatic. The nomenclature of nodal stations is based primarily on the relationship of the lymphatic drainage (lymph nodes) that follows the accompanying vessel (artery and vein) or the direct relationship with the regional organ. The commonly accepted normal nodal size for the abdomen varies between 5 mm and 10 mm in shortest axis diameter [2–6]. A table of normal size lymph nodes for various nodal

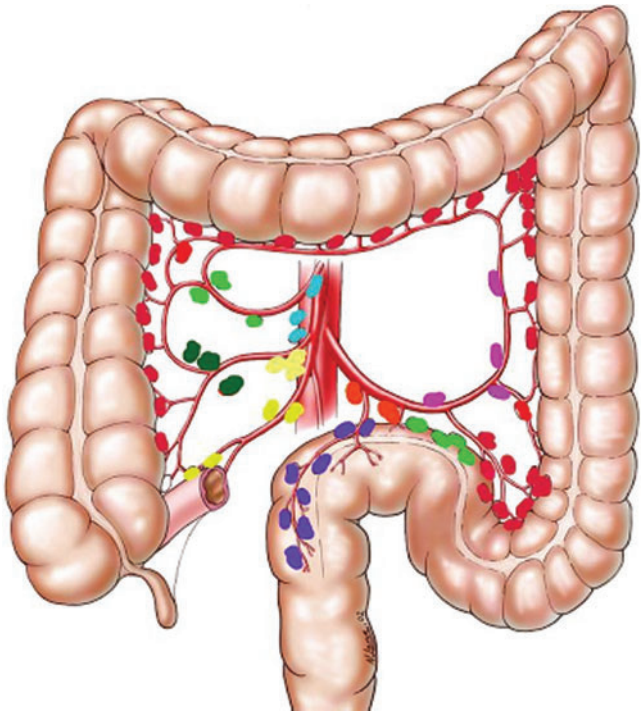

Figure 4. Diagram of the abdomen: right colic (dark green); superior mesenteric (aqua); middle colic (light green); paracolic (red); left colic (pink); sigmoid (purple); inferior mesenteric (orange).

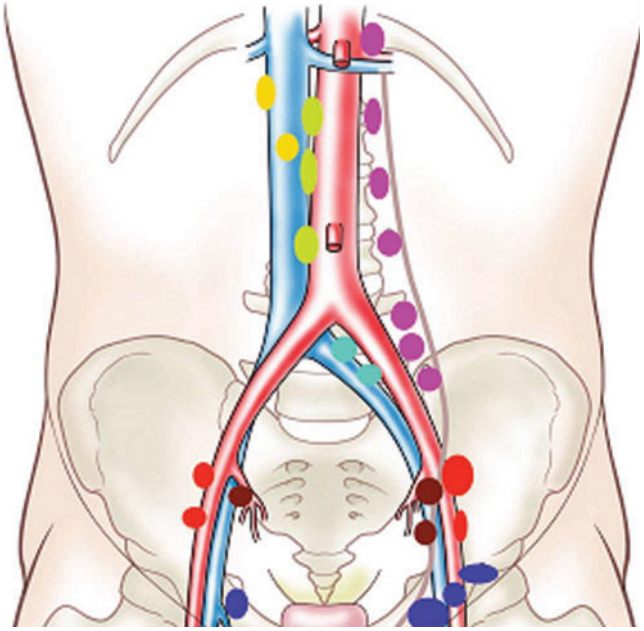

Figure 5. Diagram of the abdomen: interaortocaval (green); inguinal (blue); internal iliac (dark red); external iliac (red); pre-caval (yellow); common iliac (light blue); left para-aortic (pink).

stations in the body has been reported in the literature [7]. Various publications have reported a low accuracy for detecting malignant lymph nodes based on size parameters [8, 9]. Thus size criteria are a very controversial parameter as malignancy can be present in normal sized LNs [10] and, conversely, there may be enlarged LNs that may be not neoplastic [11]. Other than size criteria, close proximity to an anatomical tumour spread pathway and imaging features (*i.e.* PET/CT or in MRI with nanoparticles) may be helpful in suspecting that a lymph node is malignant rather than reactive [7, 12, 13].

Using colour-coded CT images; this pictorial review will present a method to learn the nomenclature of regional nodal stations by reviewing the nodal spread of common malignancies of the abdomen.

This pictorial review will present the staging and regional nodal spread for cancers of the stomach, pancreas, liver, colon and kidney. Our nomenclature is based on the American Joint Committee on Cancer (AJCC) staging of regional nodes [14].

This pictorial review with the aid of colour-coded CT images of the abdomen will also present the nomenclature and location of the nodal stations for common malignancies of the abdomen.

Gastric cancer

Gastric cancer is the third most common gastrointestinal malignancy and is the sixth leading cause of cancer death. The most common histological type is adenocarcinoma (95%). It is most commonly located in the lesser curvature (60%). Some of the related risk factors are smoking, nitrites, nitrates, pernicious anaemia, chronic atrophic gastritis and villous polyp. The 5 year survival rate for a curative

Table 1. Nodal staging for specific types of cancer (AJCC)

Gastric cancer	*Colorectal cancer*
NX Regional lymph node(s) cannot be assessed	NX Regional lymph nodes cannot be assessed
N0 No regional lymph node metastasis	N1 Metastasis in 1 to 3 regional lymph nodes
N1 Metastasis in 1 to 6 regional lymph nodes	N2 Metastasis in 4 or more regional lymph nodes
N2 Metastasis in 7 to 15 regional lymph nodes	
N3 Metastasis in more than 15 regional lymph nodes	
Pancreatic cancer	*Renal cell carcinoma*
NX Regional lymph nodes cannot be assessed	NX Regional lymph nodes cannot be assessed
N0 No regional lymph node metastasis	N1 Metastases in a single regional lymph node
N1 Regional lymph node metastasis	N2 Metastasis in more than one regional lymph node
Hepatocellular carcinoma	
NX Regional lymph nodes cannot be assessed	
N0 No regional lymph node metastasis	
N1 Regional lymph node metastasis	

Table 2. Regional lymph nodes for specific types of cancer (AJCC)

Gastric cancer	*Hepatocellular carcinoma*
Greater curvature of stomach	Hepatoduodenal ligament, Figure 12
Greater curvature, Figures 6, 8	Caval lymph nodes, Figure 18
Greater omental, Figure 13	Hepatic artery, Figures 7, 11
Gastroduodenal, Figure 9	
Gastroepiploic, Figures 9, 10	
Pyloric, Figure 15	*Colorectal cancer*
Pancreaticoduodenal lymph nodes, Figure 13	Pericolic/perirectal, Figures 9, 17, 18
	Ileocolic, Figures 19, 20
Pancreatic and splenic area	Right colic, Figure 8
Pancreaticolienal, Figure 13	Middle colic, Figure 7
Peripancreatic, Figures 10, 13	Left colic, Figure 17
Splenic, Figure 13	Inferior mesenteric artery (IMA), Figures 19, 21
	Superior rectal (haemorrhoidal), Figure 22
Lesser curvature of stomach	
Lesser curvature, Figure 7	
Lesser omental	
Left gastric, Figure 6	*Renal cell carcinoma*
Cardio-oesophageal	Renal hilar, Figures 14, 16
Common hepatic, Figure 12	Paracaval, Figure 18
Hepatoduodenal ligament, Figure 17	Para-aortic, Figures 17, 18
	Periaortic (lateral aortic), Figure 18
	Retroperitoneal NOS, Figures 17, 18
Pancreatic cancer	
Peripancreatic, Figures 10, 11, 13	
Hepatic artery, Figures 7, 11	
Coeliac axis, Figures 12, 13	
Pyloric, Figure 15	
Splenic region, Figure 13	

surgical resection ranges from 30% to 50% (stage II) and from 10% to 25% for patients with stage III disease [14]. Adjuvant therapy has been considered.

The nodal staging for gastric cancer based on AJCC criteria is listed in Table 1. Table 2 lists the regional lymph nodes for gastric cancer and the corresponding CT colour-coded images of the abdomen demonstrating the anatomical location.

Pancreatic cancer

Pancreatic cancer is the second most common gastrointestinal malignancy and is the fifth leading cause of cancer-related death. The majority of cases are ductal adenocarcinomas (exocrine ductal epithelium, 95% of cases). Pancreatic cancer generally develops without early symptoms, except when it is close to the bile duct and causes biliary obstruction. Up to two-thirds may be located in the head of the pancreas. Approximately 30% of cases are related to smoking and 20% are associated with the type of

Table 3. Additional lymph nodes for lymphoproliferative disorders

Retrocrural, Figure 23
Inferior diaphragmatic, Figure 23
Anterior diaphragmatic, Figure 24
Middle diaphragmatic, Figure 24
Gastro-oesophageal, Figure 24

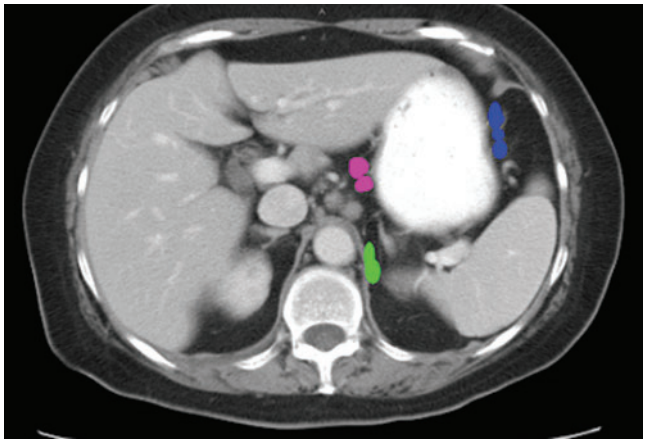

Figure 6. CT image of the abdomen demonstrates the following nodal stations: left gastric (pink); greater curvature (blue); left inferior phrenic (green).

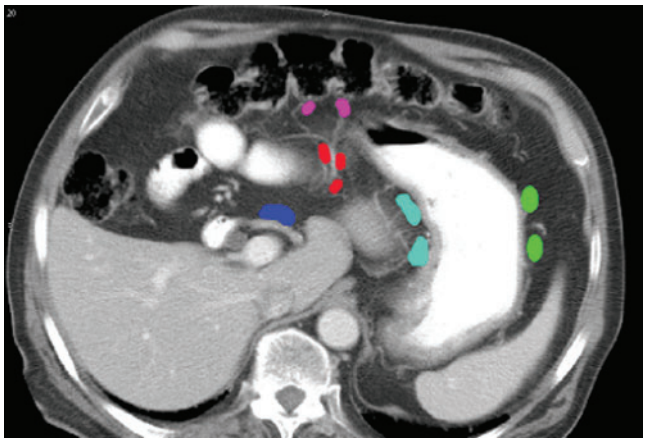

Figure 7. CT image of the abdomen demonstrates the following nodal stations: lesser curvature (light blue); hepatic artery (blue); greater curvature (green); pericolic (pink); middle colic (red).

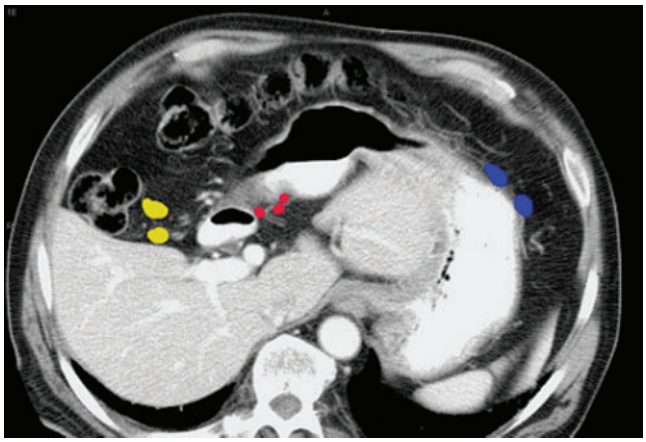

Figure 8. CT image of the abdomen demonstrates the following nodal stations: greater curvature (blue); right gastric (red); right colic (yellow).

Figure 9. CT image of the abdomen demonstrates the following nodal stations: gastroduodenal (green); pericolic (pink); superior mesenteric (light blue); interaortocaval (yellow); right gastroepiploic (red).

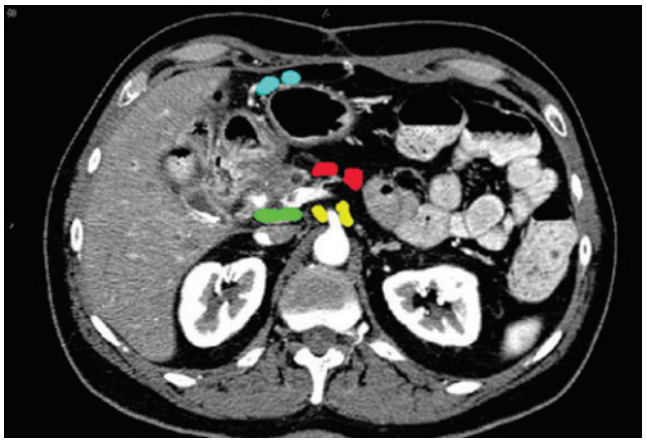

Figure 10. CT image of the abdomen demonstrates the following nodal stations: right gastroepiploic (light blue); periportal (green); superior mesenteric (yellow); inferior pancreatic (red).

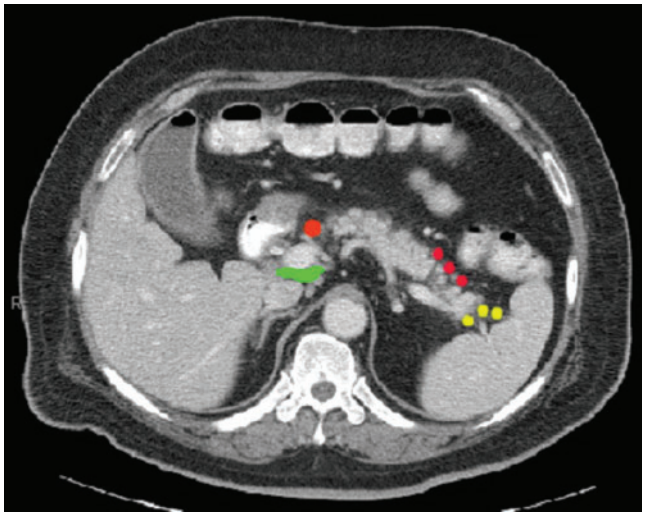

Figure 11. CT image of the abdomen demonstrates the following nodal stations: splenic (yellow); periportal (green); anterior pancreatic (red); hepatic (orange).

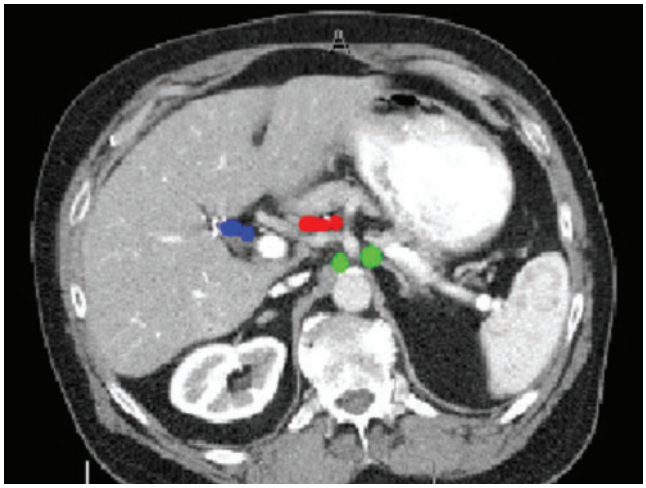

Figure 12. CT image of the abdomen demonstrates the following nodal stations: coeliac axis (green); hepato-duodenal (blue); common hepatic (red).

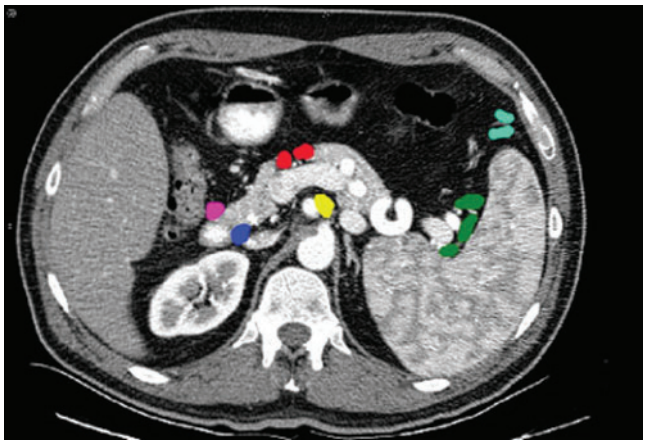

Figure 13. CT image of the abdomen demonstrates the following nodal stations: coeliac axis (yellow); splenic (green); greater omental (light blue); anterior pancreatico-duodenal (pink); posterior pancreaticoduodenal (blue); pancreatic inferior (red).

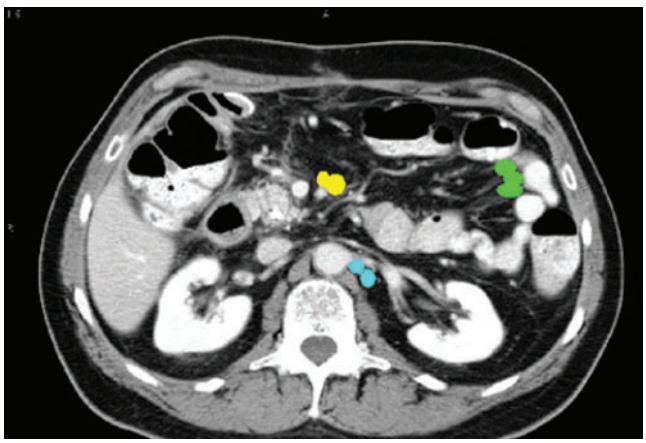

Figure 14. CT image of the abdomen demonstrates the following nodal stations: juxtaintestinal (green); renal hilar (light blue); superior mesenteric (yellow).

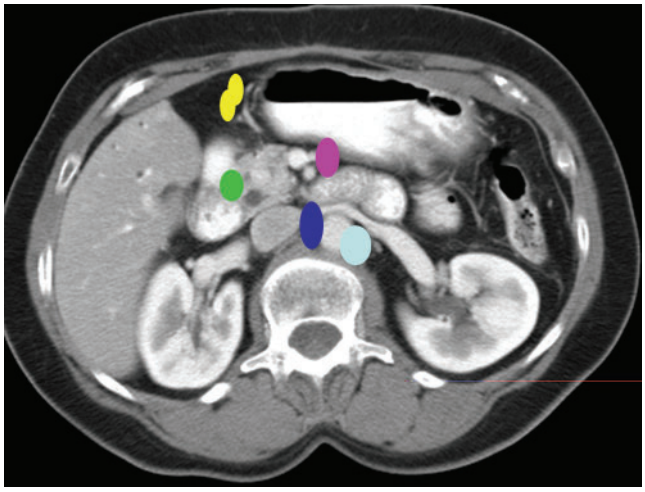

Figure 15. CT image of the abdomen demonstrates the following nodal stations: lateral aortic (light blue); right gastroepiploic (yellow); interaortocaval (blue); pyloric (green); superior mesenteric (pink).

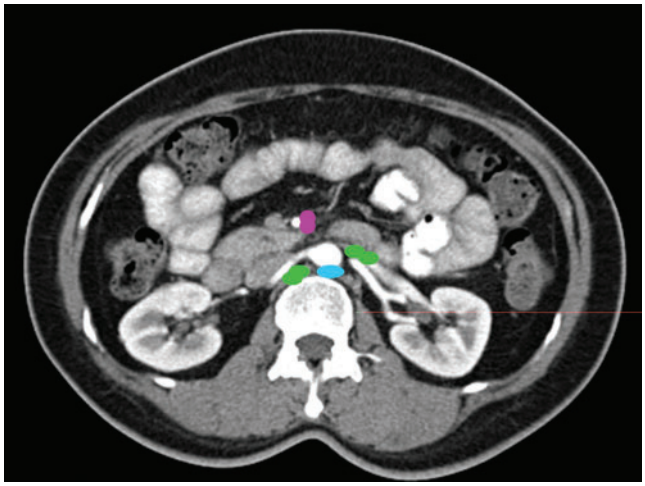

Figure 16. CT image of the abdomen demonstrates the following nodal stations: renal hilar (green); retro-aortic (light blue); superior mesenteric (pink).

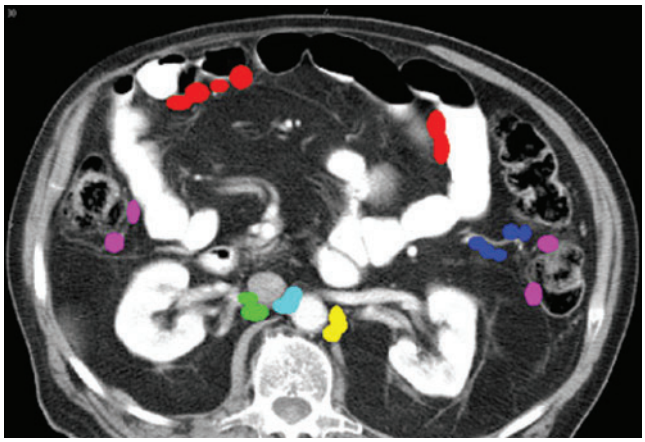

Figure 17. CT image of the abdomen demonstrates the following nodal stations: lateral aortic (yellow); retrocaval (green); interaortocaval (light blue); juxtaintestinal (red); pericolic (pink); left colic (dark blue).

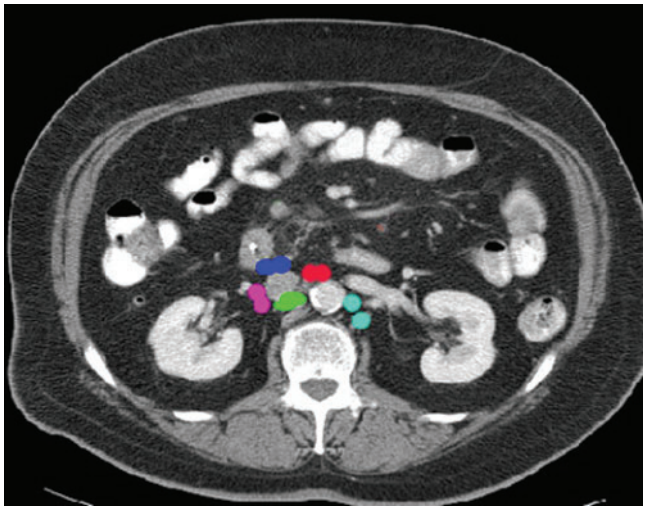

Figure 18. CT image of the abdomen demonstrates the following nodal stations: lateral aortic (light blue); retrocaval (green); lateral caval (pink); pre-aortic (red); pre-caval (dark blue).

diet (high in fat). Risk is also increased with obesity, chronic pancreatitis, prior gastric surgery, diabetes, cirrhosis and exposure to radiation or chemicals [15, 16]. It is resectable only in approximately 10% of the cases at presentation. The resectability of a local tumour depends on the involvement of major vascular structures, mainly arterial structures (coeliac axes, superior mesenteric artery), and length of involvement or occlusion of major venous structures (superior mesenteric vein) [14]. The identification of nodal disease is difficult. The accuracy of both CT and MRI is limited [17, 18]. The survival without treatment is 5 months and with treatment (surgery ± neoadjuvant chemoradiation with poor results) 8–14 months [16].

The nodal staging for pancreatic cancer based on AJCC criteria is listed in Table 1. Table 2 lists the regional lymph nodes for pancreatic cancer and the corresponding CT colour-coded images of the abdomen demonstrating the anatomical location.

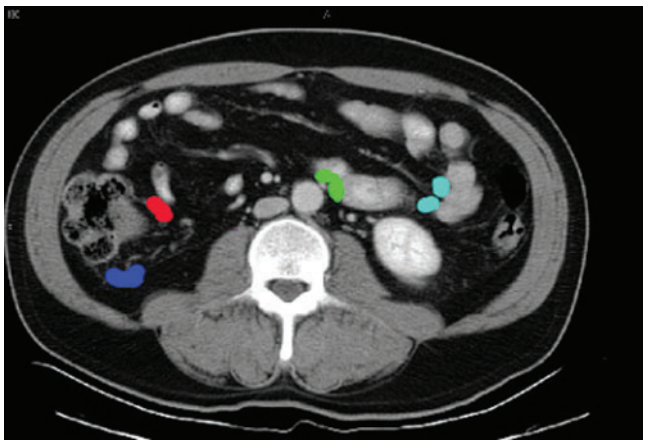

Figure 19. CT image of the abdomen demonstrates the following nodal stations: inferior mesenteric (green); juxtaintestinal (light blue); anterior ileocolic (red); posterior ileocolic (dark blue).

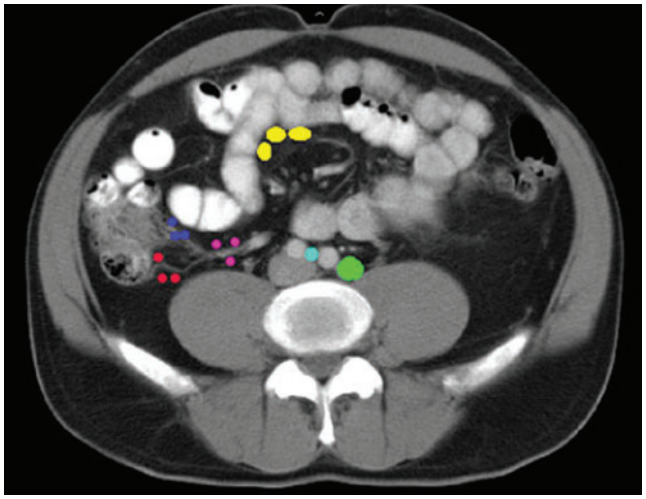

Figure 20. CT image of the abdomen demonstrates the following nodal stations: juxtaintestinal (yellow); medial common iliac (light blue); lateral common iliac (green); ileocolic (pink); anterior cecal (dark blue); posterior cecal (red).

Hepatocellular carcinoma

Hepatocellular carcinoma (HCC) is the most common primary visceral malignancy [14]. The age at diagnosis is usually between 60 and 70 years with a male predominance of 5:1. HCC originates from the hepatocytes and has fatty and fibrous elements. The main risk factor is cirrhosis in up to 90% of cases (alcohol, viral hepatitis B and C). The mean survival time is 10 months. However, with limited-stage disease and aggressive treatment survival of 5 years may be achieved.

The nodal staging for HCC based on AJCC criteria is listed in Table 1. Table 2 lists the regional lymph nodes for hepatocellular carcinoma and the corresponding CT colour-coded images of the abdomen demonstrating the anatomical location.

Colorectal cancer

Colorectal adenocarcinoma is the third most common cancer and the third most common cause of cancer

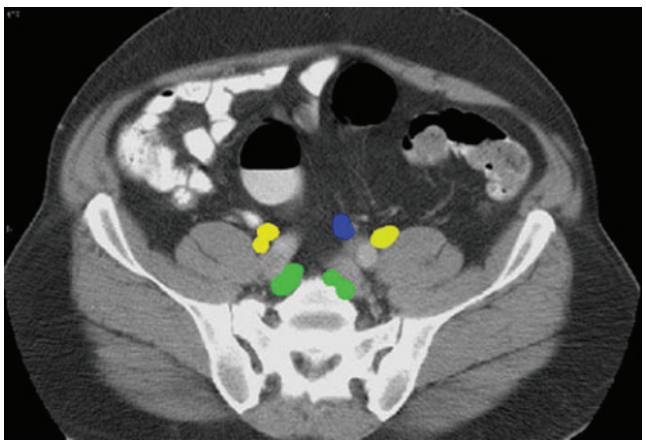

Figure 21. CT image of the abdomen demonstrates the following nodal stations: promontory (green); lateral common iliac (yellow); inferior mesenteric (blue).

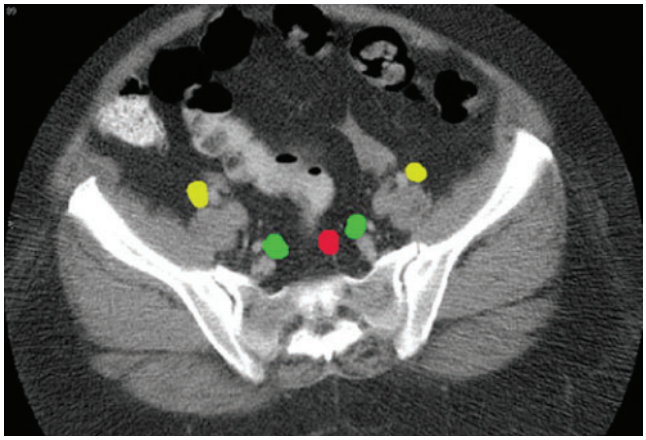

Figure 22. CT image of the abdomen demonstrates the following nodal stations: internal iliac (hypogastric, green); external iliac (yellow); superior rectal (red).

deaths [14]. Over 90% of cases occur in people over the age of 50 years [16]. Most cases arise from adenomatous polyps. It is associated with a personal or family history of colorectal cancer, polyps or inflammatory bowel disease. Other risk factors are diet low in fibre/high in fat and animal protein, obesity, asbestos workers and socioeconomic status. The treatment for rectal cancer is surgical resection, usually preceded by radiation therapy and sometimes by chemotherapy. The prognosis is determined by stage. The 5 year survival for stage I colorectal cancer is over 90% and approaches 0% for stage IV rectal cancer [14, 16].

The distribution of regional LN metastasis in colorectal carcinoma follows the vascular distribution of the vessels in the mesocolon. These vessels include the ileocolic vessels and right colic vessels for the ascending

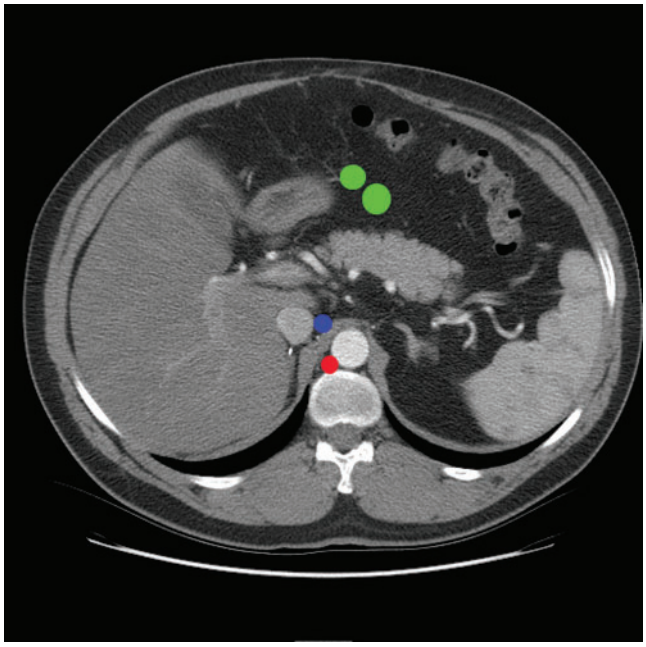

Figure 23. CT image of the abdomen demonstrates the following nodal stations: retrocrural (red), inferior diaphragmatic (blue), middle colic (green).

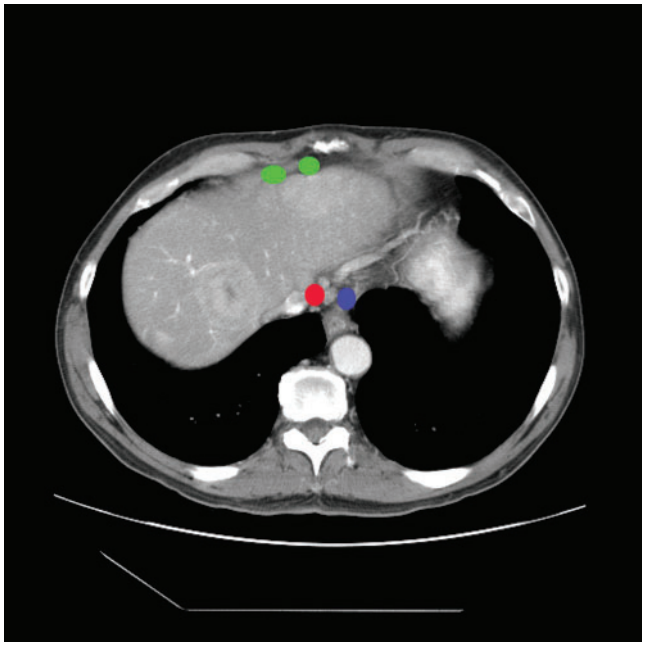

Figure 24. CT image of the abdomen demonstrates the following nodal stations: anterior diaphragmatic (green), gastro-oesophageal (blue); middle diaphragmatic (red).

mesocolon, the middle colic vessels for the transverse mesocolon, and the inferior mesenteric vein for the sigmoid and descending mesocolon [19, 20]. Recognition of this anatomy is helpful in the identification of the spread of the disease and also in the identification of the pattern of recurrent disease after treatment.

The nodal staging for colorectal cancer based on AJCC criteria is listed in Table 1. Table 2 lists the regional lymph nodes for colorectal cancer and the corresponding CT colour-coded images of the abdomen demonstrating the anatomical location.

Renal cell carcinoma

Renal cell carcinoma (RCC) is a relatively rare neoplasm. It corresponds to 3% of all malignancies [14]. It is usually seen in the fifth to seventh decade of life. The most common type is adenocarcinoma (90%). The main risk factors are tobacco, VHL and haemodialysis. More than 50% of patients with RCC are cured in the early stages, but the outcome for stage IV disease is poor. The treatment is radical nephrectomy or chemotherapy.

The nodal staging for RCC based on AJCC criteria is listed in Table 1. Table 2 lists the regional lymph nodes for RCC and the corresponding CT colour-coded images of the abdomen demonstrating the anatomical location.

Lymphoproliferative diseases

Abnormal lymph nodes can be seen in the abdomen outside the described regional lymph nodes. Lymphoma and some other lymphoproliferative disorders can present as enlarged, abnormal morphology and/or low attenuation lymph nodes. Table 3 lists additional common nodal stations in the abdomen that were not

included in Table 2 but are common sites of disease presentation in lymphoproliferative disorders.

Conclusion

This pictorial review can be used as a handbook to learn the nomenclature, location and regional lymph nodes for the most common abdominal neoplasms as detected with CT imaging.

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