

Surgical anatomy of gastric lymphatic drainage

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Abstract: The lymphatic system of the stomach is a multidirectional and complex network composed of lymphatic nodes and vessels. Lymph node metastasis is the most important prognostic factor in curable gastric cancer and lymph node dissection is one of the main areas of surgical research in gastric cancer. Therefore the anatomical classification and embryological development of the gastric lymphatic system have been well described in the literature. The current description of the gastric lymphatic system of the stomach has a surgical orientation and follows the recommendations of the Japanese Gastric Cancer Association. A thorough knowledge of the lymphatic system surrounding the stomach proves to be invaluable to surgeons treating patients with gastric cancer. The aim of this paper is to provide a concise review about surgical anatomy of the gastric lymphatic drainage.

Keywords: Lymph node anatomy; stomach; gastric cancer; surgical anatomy

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Introduction

The knowledge of the lymphatic system dates back several centuries ago and its detailed description was made by Rouvière in 1932 (1). Lymph nodes are satellites of the arteries and the same organ can be drained in different lymph node chains simultaneously. Lymph nodes are designated by the name of the organ to which they are attached, or by the name of the artery to which they are close. It is thus possible to make a topographical description.

Most of the lymphatic drainage from the stomach reaches the celiac nodes after passing through intermediary nodes. The lymph from the gastric wall drains into lymphatic vessels that arise in the mucosa, then form a rich network in the submucosa and then come together in a sub-peritoneal plexus. Finally lymphatic vessels drain into the peri-gastric lymphatic system, which is distributed along the major arteries which feed the stomach.

The first TNM anatomical classification of the lymphatic

system of the stomach has been proposed in the 1960s by the Union International Contre le Cancer and the American Joint Committee on Cancer (2), unified in 1987 in one version (3,4).

More recently several techniques have been developed to investigate the gastric lymphatic drainage such as lymphangiography, lymphoscintigraphy, vital staining of lymph node with carbon particle suspensions or dyestuff (5,6).

The current description of the lymphatic system of the stomach, however, has a surgical orientation and follows the recommendations of the Japanese Research Society for Gastric Cancer (JRSGC) (7).

Materials and methods

The electronic databases MEDLINE, Current Contents, PubMed, and references from relevant articles were used with the following search terms: “surgical anatomy” “lymphatic system”, “lymph node dissection”, and “gastric

cancer”.

Only papers published in English up to January 2016 were selected.

Lymphatic system of the stomach

Lymphatics from the upper third of the stomach spread into different vessels along the left gastric artery, the posterior gastric artery, the splenic artery and left inferior phrenic artery without lymphatic connection with the retro-pancreatic or mesenteric nodes (station 13 and 14) (8).

From the lower third of the stomach lymphatics channels along the common hepatic artery and the superior mesenteric artery, draining into station 12 and 13 (hepatoduodenal ligament nodes and retro-pancreatic nodes).

Finally the gastric lymphatic drains into lymph node station 16.

Four lymphatic axis connect the peri-gastric nodes with the para-aortic nodes (8):

- (I) Lymphatic vessels from the upper and middle part of the stomach reach, through the left inferior phrenic artery, the left sub-diaphragmatic pedicle;
- (II) Lymphatic vessels from the upper and lower part of the stomach reach the celiac pedicle through lymph node connections along the left gastric, splenic and common hepatic arteries;
- (III) Lymph flow from the lower portion of the stomach reach the superior mesenteric pedicle through the infra-pyloric nodes and the root of the superior mesenteric artery;
- (IV) Lymph flow from the lower portion of the stomach reach the retro-pancreatic pedicle through the lymphatics from retro-pyloric nodes (station 8, 12, 14).

Lymphatic flow from stations 4sa and 4sb (along the greater curvature) can be going to splenic hilum nodes (station 10) or along splenic artery nodes (station 11) through the posterior gastric artery, draining definitively into station 16a1. Lymphatic vessels from left para-cardial nodes (station 2) drain into station 16 through the left sub-diaphragmatic pedicle (8).

Lymphatic nodes of the station 4d (along the greater curvature) drain mainly through the infra-pyloric nodes (station 6) into the superior mesenteric pedicle. Furthermore, these nodes can drain into the retro-pyloric lymph nodes, and through the retro-pancreatic pedicle, drain to the stations 16a2 and 16b1.

Lymph nodes from station 3 and 1 (lesser curvature and

right para-cardial nodes) drain lymph into station 7 and 9 (left gastric artery nodes and coeliac trunk nodes); through the celiac pedicle they are connected to stations 16a2 and 16b1 (para-aortic nodes above and below the left renal vein) (8).

Lymph node involvement in gastric cancer

Several studies conducted on anatomy and physiology identified different pathways of gastric lymphatic drainage according to the gastric regions (1,6).

The percentages of lymph node metastasis in different lymphatic groups have an embryologic rationale and are closely related to the site of the gastric tumor (9).

Maruyama *et al.* reported the presence of a complex, intricate and multidirectional lymphatic system in the stomach (10). The designs of lymphatic metastasis were confirmed by several studies on single nodal metastasis (11,12) and analyses of lymph node involvement (13,14).

In 85–90% of patients with single peri-gastric lymph node metastasis, metastatic nodes are located on the same site of the tumor, but if the number of metastatic nodes increases the distribution of metastatic lymph nodes changes (15).

According to the site of the tumor, lymph node metastases are more frequently observed in specific stations and the degree of gastric wall invasion is related to the probability to encounter a metastatic lymph node (13–15).

Upper third adenocarcinoma of the stomach

Adenocarcinomas of the upper third of the stomach are associated to lymph node metastases in variable percentage between 44% and 80% of cases (13,16,17). In early gastric cancer the incidence of nodal metastases is 2–50%, while in advanced gastric cancer the frequency increases up to 65–89% (13–17).

Nodes of station 1, 2 and 3 are more frequently involved in metastasis, while among extra-peri-gastric nodes, station 7 and 9 are frequently involved. In upper gastric tumors splenic hilum nodes and para-aortic nodes is mainly infiltrated (7,10,13).

The incidence of metastatic nodes at station 10 (splenic hilum) is related to gastric wall invasion and varies from 12% to 28%: in early gastric cancer is null, in cancer with invasion of muscularis propria or subserosa is in the range of 0–8%, while in case of invasion of serosa or adjacent structures varies from 22% and 39% (13,18). Furthermore several studies show that nodes of the splenic hilum are more frequently metastatic if gastric tumors are located

at the greater curvature or the posterior wall, because the upper part of the stomach also drains into the splenic hilum nodes also through lymph vessels along the posterior gastric artery. In advanced gastric cancer para-aortic (station 16) nodal metastases occur in 16–38% of cases (7,10,13).

Middle third adenocarcinoma of the stomach

The incidence of nodal metastases in adenocarcinomas of the middle third of the stomach varies from 37% to 65% (13). In early gastric cancer the incidence of metastatic nodes range from 0% to 31% (13,19), while in advanced gastric cancer (T3–T4) the frequency of metastasis varies from 62% to 90% (13).

Lymph node stations more frequently involved are 1, 3, 4 and 6. Among extraperigastric nodes, left gastric artery and coeliac trunk nodes are frequently involved by tumor metastasis (7,10,13). Station 10 and 16 are less frequently involved than in gastric upper third tumors and only in case of tumors with invasion of the serosa or adjacent structures (17–23% of cases) (13).

Lower third adenocarcinoma of the stomach

Lymph node invasion in lower third adenocarcinoma of the stomach was detected in 50–59% of the cases (13,16).

The incidence of lymph node metastases is associated to the depth of gastric wall invasion: in intramucosal tumors is about 2%, in submucosal tumors is 20%, in case of invasion of the muscularis propria or subserosa is 57%, while when serosa or adjacent organs are invaded is 86% (19).

Among extraperigastric nodes station 3, 4, 6 and 7 are frequently involved by tumor metastasis (35–49% of cases) (7,10,13). Nodes of station 4d are metastatic in 30% of tumors with invasion of the muscularis propria/subserosa and in 46% if the serosa/adjacent structures are invaded (13), while lymph node stations 4sa and 4sb are less commonly involved.

Nevertheless nodes of station 8 and 9 are frequently involved; notwithstanding, station 14 is infiltrated from 20% to 25% in T2–T3/4 cases (7,10,13).

Skip metastasis

Gastric adenocarcinoma can spread to distant lymphatic stations, jumping contiguous nodes, but the modality of occurrence of skip metastasis remains unclear.

Different studies reported that the skip metastasis frequently involving left gastric artery, common hepatic artery and coeliac trunk nodes, their incidence varies from 5% to 14% (11,12,15,20).

Maruyama described that 11% of patients had histologically uninvolved peri-gastric nodes, of these patients the skip metastasis involved stations 7 to 11 in 24% of cases, hepatoduodenal ligament nodes and para-aortic nodes in 1% of cases (10).

A recent study of Choi *et al.* performed on a large population of 2,231 patients, reported that the incidence of skip metastasis varies from 1.8%, among the overall gastric cancer population, to 4.8% among the patients with metastatic lymph nodes. The commonest location of skip metastasis was station 7 (63.2%), then station 8 and 9 (33% and 30.2%). The skip metastasis involved one lymphatic station in 79.2% of patients (21).

Conclusions

Surgical resection remains the primary curative therapy for gastric cancer and lymph node metastases is the best predictor of recurrence and overall survival. The standardized lymph node dissection was established about 30 years ago by JRSGC. The extent of lymphadenectomy has been subjected of a worldwide debate and many trials regarding this issue have been performed.

Extended lymph node dissection remain the standardized lymph node dissection in the Eastern countries, while more limited lymphadenectomy in the last years represented the standard of care in Western countries. Recent updates of European and the USA guidelines have incorporated the extended lymphadenectomy according to the 3rd English edition of the Japanese Classification of Gastric Carcinoma (7).

The extent of lymph nodes dissection according to the type of gastrectomy was defined as follows: in total gastrectomy D1 lymph node dissection includes lymph node stations from 1 to 7, D1+ includes D1 and stations 8a, 9, and 11p, D2 includes D1+ and 10, 11d, and 12a; for tumors located across the esophagogastric junction D1+ includes station 110 and D2 stations 19, 20, 110 and 111; for distal gastrectomy, D1 lymph node dissection includes lymph node stations 1, 3, 4sb, 4d, 5, 6 and 7, D1+ includes D1 stations plus stations 8a, and 9, D2 includes D1 stations plus stations 8a, 9, 11p, and 12a.

The knowledge of the lymphatic drainage of the stomach and lymph node spread in gastric cancer is crucial to make a correct lymphadenectomy.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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