Translational Research in Anatomy 31 (2023) 100246

Contents lists available at ScienceDirect

Translational Research in Anatomy

journal homepage: www.elsevier.com/locate/tria

The apron of the greater omentum of gastric cancer patients contains various lymphoid structures including lymph nodes

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ARTICLE INFO

Keywords:
Omentum
Milky spots
Lymph nodes
Gastric cancer
Secondary lymphoid tissue
Peritoneum
Lymphatic metastasis

ABSTRACT

Purpose: To gain more insight into the pattern of peritoneal cancer dissemination and optimize cancer treatment, it is important to improve our understanding of the omental lymphatic system. Although omental milky spots (OMSs) are considered the only lymphoid structures in the omentum, clinical studies mention the presence of lymph nodes (LNs) as well. This discrepancy may be explained by the fact that OMSs are highly dynamic structures and may erroneously be mistaken for LNs. The aim of this study was to evaluate the lymphoid structures, and mainly the presence of lymph nodes, in the apron of the greater omentum.

Basic procedures: In this study, diagnostic samples of the greater omentum of 17 gastric cancer patients that were previously reported to contain LNs were re-evaluated for their presence. Paraffin embedded omental samples were stained with Picrosirius red, smooth muscle actin and CD20 and CD3, and microscopically re-examined according to predefined criteria to distinguish OMSs from LNs.

Main findings: Pathology records reported 47 LNs in 17 patients. Upon re-evaluation, 20/47 LNs could be classified as true LNs and were located in both the upper and lower quadrants of the greater omentum. The other 27 structures could not be classified as LNs or OMSs and were defined as intermediate lymphoid structures.

Conclusions: The omental apron of gastric cancer patients contains LNs and intermediate lymphoid structures, the latter most likely representing activated OMSs. These observations underline that our understanding of the lymphatic system of the greater omentum is incomplete and requires additional studies to gain further insight in its structure and function in both health and disease.

1. Introduction

The lymphatic system, composed of lymph vessels and lymphoid organs, plays a significant role in regulation of tissue fluid balance, transport of dietary fats, and immune surveillance [1,2]. Furthermore, it is of importance in cancer cell dissemination and the development of (lymph node) metastases [3]. The latter underlines the clinical significance of proper understanding of the anatomy of the lymphatic system (see Table 1).

An important knowledge gap, however, is present in the lymphatic system of the greater omentum; a peritoneal double fold suspending from the outer margins of the stomach and which represents a frequent location of metastases of ovarian and gastric cancer [4–6]. Debate exists on the presence of lymph nodes (LNs) in the omental apron: while a comprehensive anatomical reference work [7] considers omental milky spots (OMSs) as the only lymphoid structures, clinical literature and diagnostic reports (e.g. of gastric cancer patients that underwent omentectomy) often report the presence of LNs [8,9]. We hypothesize that pathologists might have wrongly identified OMSs as LNs as they share morphologic characteristics, especially when OMSs are activated [10–12]. However, from an oncological perspective it is of clinical importance to understand which lymphoid structures reside in the

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https://doi.org/10.1016/j.tria.2023.100246
Received 21 February 2023; Received in revised form 21 April 2023; Accepted 21 April 2023
Available online 11 May 2023

Table 1
Baseline characteristics.

	N = 17
Age at diagnosis in years, median (range)	72 (35–87)
Sex, n (%)	
Male	8 (47.1)
Female	9 (52.9)
Histology	
Adenocarcinoma	17 (100)
Tumor location	
Gastro-esophageal junction	1 (5.9)
Proximal (cardia/fundus)	7 (41.2)
Middle (corpus)	1 (5.9)
Distal (antrum/pylorus)	8 (47.1)
Clinical T stage	
T1	2 (11.8)
T2	5 (29.4)
T3	9 (52.9)
Missing	1 (5.9)
Clinical N stage	
N0	7 (41.2)
N1	6 (35.3)
N2	3 (17.6)
Missing	1 (5.9)
Clinical M stage	
M0	16 (94.1)
M1	1 (5.9)
Neoadjuvant treatment	
Chemotherapy	12 (70.6)
Chemoradiation	1 (5.9)
None	4 (23.5)
Type of surgery	
Total gastrectomy	11 (64.7)
Distal gastrectomy	6 (35.3)

omentum. LNs monitor circulating lymph and if tumor cells are observed in omental LNs of a gastric cancer patient, this is considered to result from lymphatic (and hence local) spread. Presence of tumor cells in OMSs, which monitor peritoneal fluid, suggest a more extensive disease as exfoliated tumor cells have spread throughout the peritoneal cavity [13,14]. Both necessitate different treatment strategies.

In this exploratory study we evaluated the lymphoid structures present in the greater omentum. We selected patients that underwent omentectomy (in our institute this is performed on most gastric cancer patients) and of which the pathologist reported the omentum to contain LNs. We retrieved the paraffin embedded lymphoid structures and aimed to re-evaluate them according to predefined histomorphological criteria that allowed us to distinguish between LNs and OMSs. Additionally, these lymphoid structures were screened for the presence of tumor metastases.

2. Material and methods

Institutional Review Board approval was obtained and informed consent requirement was waived. Pathology reports of gastric cancer patients who underwent gastrectomy with removal of the omentum (not including the gastrocolic ligament containing station 4 lymph nodes) between April 2012 and October 2018 were screened for the presence of omental LNs. Of the 103 reviewed patient reports, 17 (16,5%) listed omental LNs. Of these 17 patients, the paraffin blocks containing omental LNs (a total of 47) were retrieved and re-examined according to predefined LN specific histomorphological criteria [15]. The three criteria which were used and reliably distinguish between LNs and OMSs include: the presence of a smooth muscle rich capsule and trabeculae, separate B and T cell regions and a layered organization with, from the outside in a capsule, cortex, paracortex and medulla. Although afferent lymphatic vessels and a subcapsular sinus represent LN specific morphological hallmarks, these structures are not included due to a lack of reliable discriminative capacity [15].

In order to do so, 5 μm sections were cut and stained histochemically with hematoxylin and eosin (HE), Picrosirius red or immunohistochemically with antibodies against smooth muscle actin, and B and T cells. Staining and evaluation procedures were performed according to a previously described method [15], including the same antibodies and positive and negative controls. Additionally, HE stained sections of all blocks were morphologically assessed for the presence of tumor metastases.

Each of the paraffin blocks and hence the observed lymphoid structures, could be allocated to a quadrant of the omental apron, being the left and right upper, and left and right lower quadrants (Fig. 1), which were marked during surgery by the surgeon.

3. Results

Pathology reports described the presence of 47 omental LNs in a total of 17 patients. However, after screening them according to the histomorphological criteria defining a LN, only 20 out of 47 (43%) clinically defined LNs met the histomorphological criteria for LNs and were present in a total of 10 patients. These structures showed a continuous, smooth muscle containing capsule with extending trabeculae, distinct B and T cell regions, and a layered organization (from the outside in a capsule, cortex, paracortex and medulla) (Fig. 2). The medulla of the omental LNs was not always clearly observed in the sections, and often contained adipose tissue (Fig. 2). The latter represents lipomatosis, a normal age related process that leads to a gradual loss of the medullary lymphatic network [16].

All other clinically reported LNs (n = 27) did not meet all criteria to classify as true LNs. They did not show a complete continuous capsule and if smooth muscle cells were present in these capsule-like structures, these were more randomly distributed in patches. They did however contain segregated B and T cell area's but then lacked LN specific layered organization (capsule, cortex, paracortex, medulla). Since these structures could also not be classified as OMSs (small lymphoid structures without a capsule and heterogenous spread), we classified them as intermediate lymphoid structures.

3.1. Distribution of omental LNs and omental metastases

The 20 omental lymph were dispersed throughout the apron of the greater omentum, and located in both the upper and lower quadrants of the greater omentum. The distribution of omental LNs is depicted in Fig. 1.

In 1/17 patients (5.9%) the apron of the greater omentum contained multiple tumor metastases. These were all located in intermediate lymphoid structures, which were located in the left upper quadrant of the omentum (Fig. 1). This patient received upfront surgery without neoadjuvant treatment for a pT2N2 antral adenocarcinoma with metastases in 5/15 regional gastric LNs showing extracapsular growth. No omental lymph nodes were observed in this patient. No tumor deposits (solitary tumor aggregates devoid of lymphoid characteristics) were found (Fig. 3).

4. Discussion

This study showed that the lymphoid system of the greater omentum of gastric cancer patients contains a variety of lymphoid structures. We showed that LNs are present in the omental apron, also in its lower parts. The latter supports the fact that they represent true structures of the omentum and definitely not station 4 lymph nodes located in the gastrocolic ligament. Interestingly, intermediate lymphoid structures, which showed a mixture of characteristics of both OMSs and LNs, were most frequently seen. Metastases of the primary gastric tumor were seen in the omental apron of 1/17 patients and were located in intermediate lymphoid structures.

The presence of LNs in the omental apron (not including station 4 nodes in the gastrocolic ligament) is in contrast with a comprehensive

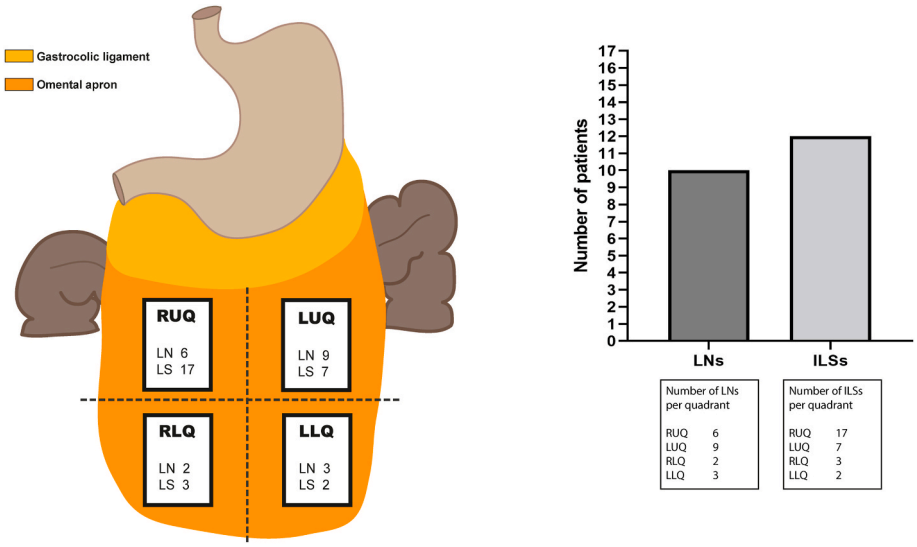

Fig. 1. Distribution and number of lymphoid structures in the omental apron of gastric cancer patients.
Abbreviations. LLQ = left lower quadrant, LN = lymph node; LS = intermediate lymphoid structure; LUQ = left upper quadrant, RLQ = right lower quadrant, RUQ = right upper quadrant.

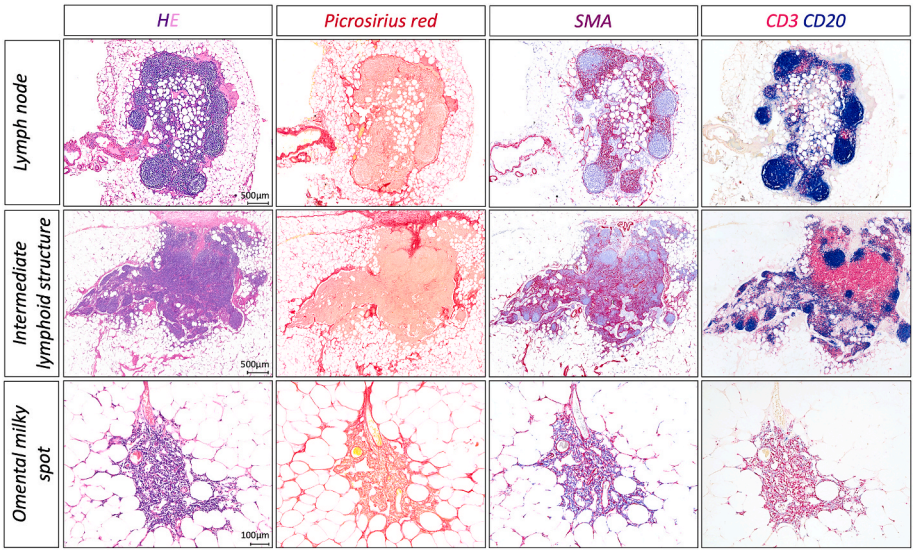

Fig. 2. Lymphoid structures in the omental apron of gastric cancer patients. Various stainings are applied to facilitate discriminating lymph nodes (LNs) from other lymphoid structures. **Picrosirius red:** LNs show a completely surrounding connective (= capsule) tissue lining whereas this is only partial or lacking in intermediate structures and omental milky spots (OMSs), respectively. Smooth muscle actin (SMA) is present in the (partial) capsule and in T cell rich areas in both LNs and intermediate lymphoid structures. SMA can also be observed in vascular structures in all three types of lymphoid structures. **CD3/CD20:** Segregated T and B cell areas can be observed in both LNs and intermediate structures. OMSs show a more homogenous presence of both cell types. *Abbreviations.* LN = lymph node, OMS = omental milky spot, SMA = smooth muscle actin. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

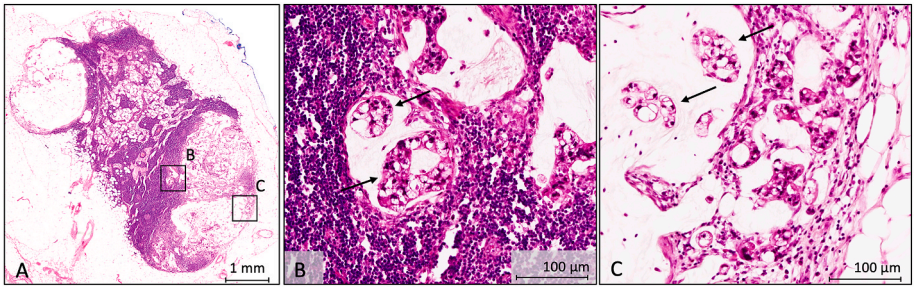

Fig. 3. Intermediate structure containing tumor metastases.
In 1/17 patients the greater omentum contained metastases, located in an intermediate lymphoid structure in the left upper quadrant. A) Low power magnification of the intermediate structure with metastases of an adenocarcinoma. B and C) high power magnification of the metastases (arrows).

anatomical reference work [7] that considers OMSs as the only lymphoid structures in the omental apron. This discrepancy might be explained by the fact that LNs in the omenta of gastric cancer patients could have evolved from OMSs and may therefore be absent in healthy omenta. OMSs are dynamic structures that are known to undergo changes upon immune stimulation [10–12] and gradually gain

characteristics reminiscent of LNs [17,18]. Whether the LNs found in this study represent residential omental structures that develop during ontogeny or OMSs that have evolved into LNs, needs to be studied in developmental and experimental studies, respectively. Lymphoid structures, including OMSs and LNs, develop prior to 38 weeks of embryonic development [19]. Since the fetal omentum contains little adipose tissue, identification of LNs and the distinction between OMSs and LNs should be easy, especially when the omentum as a whole is stained with hematoxylin [20]. Experimentally, OMSs could be studied on various time periods after a stimulus (either infectious or cancerous) to see if they show gradual morphological changes and evolve into intermediate lymphoid structures and eventually LNs. Parallels might exist between the mechanism behind the formation of tertiary lymphoid organs and activation of OMSs. Tertiary lymphoid organs are organized lymphoid structures which develop *de novo* at sites of chronic inflammation and in areas with tumor [21]. Formation of these structures is determined by site specific and inflammation dependent factors that direct stromal fibroblast to acquire LN-like properties that among others permit the retention of inflammatory cells [22], a process that might also occur during the activation on OMSs.

The exact drainage route of omental LNs is unknown, but of great importance for the understanding of cancer dissemination patterns, and in determining adequate therapeutic options. OMSs are known to drain into efferent lymphatic vessels originating in the proximity of OMSs. These coalesce with regional omental lymphatics, which drain toward lymph nodes in the gastrocolic and gastrosplenic ligament [7,23] and eventually drain into the systemic circulation via the thoracic duct. When omental LNs drain into similar efferent lymphatics and subsequently to station 4 LNs, metastases in these LNs could indicate peritoneal spread and not just local lymphatic spread as previously thought.

Our study showed the presence of intermediate lymphoid structures in a substantial number of patients. These most likely represent activated OMSs. The presence of a partial capsule and segregation of T and B cell regions with corresponding stromal cells such as fibroblastic reticular cells (FRCs), suggests that OMSs are more dynamic than previously thought. Activation of OMSs and the development into intermediate lymphoid structures could be explained by the absorption of peritoneally disseminated tumor cells or to tumor specific circulating chemokines secreted to the peritoneal cavity by the primary tumor and/or surrounding stromal cells. Since OMSs represent selective implantation sites for tumor cells in peritoneal dissemination [24,25], these unknown substances might contribute to their activation and hence the formation of a premetastatic niche [26], a mechanism that has been previously described to occur prior to the formation of LN metastases [27].

The presence of intermediate lymphoid structures and the associated formation of a premetastatic niche might be detrimental for patient prognosis, as the activated OMSs might provide an optimal soil for tumor metastases. Furthermore, activated OMSs might play a role in making other parts of the peritoneum more receptive for metastases by supplying the peritoneal cavity with immune cells [28,29] including subtype M2 that are known to generate an immunosuppressive environment and hereby promote cancer progression [30,31]. Interestingly, the presence of these macrophages in the peritoneal fluid appears to correlate to the occurrence of peritoneal metastases as shown in gastric cancer patients [32]. While the exact mechanism requires more research, this might explain why metastases develop in OMS first and only days later at other, non-OMS associated parts of the peritoneum [33]. Although omentectomy during gastrectomy has been debated, the aforementioned might justify omentectomy during gastric cancer surgery and necessitates thorough review during pathological assessment of the omentum for the presence of metastases. Furthermore, future studies should focus on the functional and prognostic value of intermediate lymphoid structures in metastatic disease as they might represent premetastatic warning signs.

4.1. Future directions

Results from the current study underline that our understanding of the lymphatic system of the greater omentum is far from complete. Future studies should start by addressing the development, anatomy and function of omental lymphoid structures in both health and disease. This will increase our understanding of gastric tumor spread and what additional therapy would be most effective for gastric cancer patients.

4.2. Limitations of this study

The most important limitation of this study is that it only included omental samples of gastric cancer patients, that were obtained for clinical diagnostics. It would be interesting to also evaluate the lymphoid structures in the omentum of patients without cancer and for example gastric ulcers. This to evaluate differences in the development of omental lymphoid structures in response to different stimuli. In addition, the samples that were used were obtained for clinical evaluation of metastases; the omenta were sampled based on macroscopic lesions, and if not present, random samples of each quadrant were obtained. It would be interesting to have more extensive samples, to be able to evaluate more omental lymphoid structures. However, this was only an exploratory study providing insight into the different omental lymphoid structures in “stimulated” omenta.

5. Conclusions

In conclusion, the omental apron of gastric cancer patients contains structures that fulfill the morphological criteria for LNs. Furthermore, intermediate lymphoid structures were present, which most likely represent activated OMSs. Whether the omental LNs represent activated OMSs, like intermediate lymphoid structures, or are real LNs remains unclear.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical statement

Institutional Review Board approval was obtained and informed consent requirement was waived.

Funding statement

No funding was received for this project.

CRediT authorship contribution statement

B. Schurink: Conceptualization, contributions to concept/design, acquisition of data, Funding acquisition, Formal analysis, interpretation, Writing – original draft, drafting of the manuscript. **C.G.J. Cleypool:** Conceptualization, contributions to concept/design, Funding acquisition, acquisition of data, Formal analysis, interpretation, critical revision of the manuscript and approval of the article. **L.A.A. Brosens:** acquisition of data, Funding acquisition, critical revision of the manuscript and approval of the article. **J.P. Ruurda:** Conceptualization, contributions to concept/design, critical revision of the manuscript and approval of the article. **Claire Mackaaij:** acquisition of data, Funding acquisition, critical revision of the manuscript and approval of the article. **T.A.P. Roeling:** Conceptualization, contributions to concept/design, critical revision of the manuscript and approval of the article. **R. van Hillegersberg:** Conceptualization, contributions to concept/design, critical revision of the manuscript and approval of the article. **R.L.A.W. Bleys:** Conceptualization, contributions to concept/design, critical revision of

the manuscript and approval of the article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

None.

References

[1] L.N. Cueni, M. Detmar, The lymphatic system in health and disease, Lymphatic Res. Biol. 6 (3–4) (2008) 109–122.
[2] S. Meza-Perez, T.D. Randall, Immunological functions of the omentum, Trends Immunol. 38 (7) (2017) 526–536.
[3] R.H. Farnsworth, M.G. Achen, S.A. Stacker, The evolving role of lymphatics in cancer metastasis, Curr. Opin. Immunol. 53 (2018 Aug) 64–73.
[4] F. Sun, M.G.W. Feng, Mechanisms of peritoneal dissemination in gastric cancer (Review), Oncol. Lett. 14 (2017) 6991–6998.
[5] Z. Wang, J.Q. Chen, J.L. Liu, L. Tian, Issues on peritoneal metastasis of gastric cancer: an update, World J. Surg. Oncol. 17 (1) (2019) 1–8.
[6] Y. Iwagoi, T. Motohara, S. Hwang, K. Fujimoto, T. Ikeda, H. Katabuchi, Omental metastasis as a predictive risk factor for unfavorable prognosis in patients with stage III–IV epithelial ovarian cancer, Int. J. Clin. Oncol. 26 (5) (2021) 995–1004.
[7] D. Liebermann-Meffert, THE GREATER OMENTUM anatomy, embryology, and surgical applications, Surgical, anatomy and embryology 80 (1) (2000) 275–293.
[8] M.J. Koppe, I.D. Nagtegaal, J.H.W. De Wilt, W.P. Ceelen, Recent insights into the pathophysiology of omental metastases, J. Surg. Oncol. 110 (6) (2014) 670–675.
[9] L. Haverkamp, H.J.F. Brenkman, J.P. Ruurda, F.J.W. ten Kate, R. van Hillegersberg, The oncological value of omentectomy in gastrectomy for cancer, J. Gastrointest. Surg. 20 (5) (2016) 885–890.
[10] K. Dux, R.V. Rouse, B. Keywski, Composition of the lymphoid cell populations from omental milky spots during the immune response, Eur. J. Immunol. 16 (1986) 1029–1032.
[11] L.H. Jackson-Jones, S.M. Duncan, M.S. Magalhaes, S.M. Campbell, R.M. Maizels, H. J. McSorley, et al., Fat-associated lymphoid clusters control local IgM secretion during pleural infection and lung inflammation, Nat. Commun. 7 (2016).
[12] C. Bénézech, N.T. Luu, J.A. Walker, A.A. Kruglov, Y. Loo, K. Nakamura, et al., Inflammation-induced formation of fat-associated lymphoid clusters, Nat. Immunol. 16 (8) (2015) 819–828.
[13] L.F.G. Krist, D.M. Broekhuis-fluitsma, I.L. Eestermans, S. Meyer, Milky spots in the greater omentum are predominant sites of local tumour cell proliferation and accumulation in the peritoneal cavity, Cancer Immunol. Immunother. 47 (1998) 205–212.
[14] H. Tsujimoto, T. Takahashi, A. Hagiwara, M. Shimotsuma, C. Sakakura, K. Osaki, et al., Site-specific implantation in the milky spots of malignant cells in peritoneal dissemination: immunohistochemical observation in mice inoculated intraperitoneally with bromodeoxyuridine-labelled cells, Br. J. Cancer 71 (3) (1995) 468–472.
[15] C. cleypool, C. Mackaaij, B. Schurink, R. Bleys, Morphological hallmarks facilitating distinction of omental milky spots and lymph nodes: an exploratory study on their discriminative capacity, Histol. Histopathol. 35 (11) (2020) 1275–1284.
[16] T. Bekkhus, A. Olofsson, Y. Sun, P.U. Magnusson, M.H. Ulvmar, Stromal transdifferentiation drives lipomatosis and induces extensive vascular remodeling in the aging human lymph node, J. Pathol. 259 (3) (2023 Mar 21) 236–253.
[17] K. Dux, R.V. Rouse, B. Keywski, Composition of the lymphoid cell populations from omental milky spots during the immune response, Eur. J. Immunol. 16 (1986) 1029–1032.
[18] S. Cruz-Migoni, J. Caamaño, Fat-associated lymphoid clusters in inflammation and immunity, Front. Immunol. 7 (DEC) (2016) 1–7.
[19] L.F.G. Krist, H. Koenen, W. Calame, J.J. Van Der Harten, J.C. Van Der Linden, I. L. Eestermans, et al., Ontogeny of milky spots in the human greater omentum: an immunochemical study, Anat. Rec. 249 (3) (1997) 399–404.
[20] B. Schurink, C.G.J. Cleypool, R.L.A.W. Bleys, A rapid and simple method for visualizing milky spots in large fixed tissue samples of the human greater omentum, Biotech. Histochem. 94 (6) (2019).
[21] C. Gago da Graça, L.G.M. van Baarsen, R.E. Mebius, Tertiary lymphoid structures: diversity in their development, composition, and role, J. Immunol. 206 (2) (2021 Jan) 273–281.
[22] C. Gago da Graça, L.G.M. van Baarsen, R.E. Mebius, Tertiary lymphoid structures: diversity in their development, composition, and role, J. Immunol. 206 (2) (2021 Jan 15) 273–281.
[23] G. Nylander, B. Tjernberg, The lymphatics of the greater omentum. An experimental study in the dog, Lymphology 2 (1) (1969) 3–7.
[24] H. Tsujimoto, A. Hagiwara, M. Shimotsuma, C. Sakakura, K. Osaki, S. Sasaki, et al., Role of milky spots as selective implantation sites for malignant cells in peritoneal dissemination in mice, J. Cancer Res. Clin. Oncol. 122 (10) (1996) 590–595.
[25] S. Bootsma, M.F. Bijlsma, L. Vermeulen, The molecular biology of peritoneal metastatic disease, EMBO Mol. Med. 15 (3) (2023) 1–11.
[26] R.N. Kaplan, S. Rafii, D. Lyden, Preparing the "soil": the premetastatic niche, Cancer Res. 66 (23) (2006) 11089–11093.
[27] D. Jones, E. Pereira, T.P. Padera, Growth and immune evasion of Lymph node Metastasis, Front. Oncol. 8 (2018).
[28] M. Shimotsuma, T. Takahashi, A. Hagiwara, Activation of omental milky spots and milky spot macrophages by intraperitoneal administration of a streptococcal preparation, OK-432, Cancer Res. 52 (19) (1992) 5400–5402.
[29] M. Liu, A. Silva-Sanchez, T.D. Randall, S. Meza-Perez, Specialized immune responses in the peritoneal cavity and omentum, J. Leukoc. Biol. 109 (4) (2021) 717–729.
[30] J. Mikuła-Pietrasik, P. Uruski, A. Tykarski, K. Książek, The peritoneal "soil" for a cancerous "seed": a comprehensive review of the pathogenesis of intraperitoneal cancer metastases, Cell. Mol. Life Sci. 75 (3) (2018) 509–525.
[31] T. Motohara, K. Masuda, M. Morotti, Y. Zheng, S. El-Sahhar, K.Y. Chong, et al., An evolving story of the metastatic voyage of ovarian cancer cells: cellular and molecular orchestration of the adipose-rich metastatic microenvironment, Oncogene 38 (16) (2019) 2885–2898.
[32] H. Song, T. Wang, L. Tian, S. Bai, L. Chen, Y. Zuo, et al., Macrophages on the peritoneum are involved in gastric cancer peritoneal metastasis, J. Cancer 10 (22) (2019) 5377–5387.
[33] Y. Yonemura, Y. Endo, T. Yamaguchi, T. Fujimura, T. Obata, T. Kawamura, et al., Mechanisms of the formation of the peritoneal dissemination in gastric cancer, Int. J. Oncol. 8 (4) (1996 Apr) 795–802.