**Search strategy and criteria:**

Search strategy and selection criteria for this review were identified by searches of MEDLINE/PubMed for relevant articles using the search terms “metastasis to breast”, “secondary cancers to breast”, “non-hematologic metastases to breast” and “intramammary metastasis”. The articles published between 1977 and 2019 were included in the review (last update was done in June 2019). Case reports and small case series (≤5 cases) are not presented in the table.

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| --- | --- | --- | --- |
| **Author** | **Reference** | **No of cases** | **Histotypes of metastatic cancer to the breast** |
| Moreno-Astudillo et al.  | Case Rep Radiol. 2019;2019:9454201 | 12 (2 hematologic) | Ovarian carcinoma (4), melanoma (3), lymphoma (2), gastric carcinoma (2), oral carcinoma (1) |
| Sun et al.  | Oncol Lett. 2018;15:3685-3693 | 22 | Lung (22.7%) and nasopharyngeal carcinoma (18.2%) |
| Bitencourt et al.  | Br J Radiol. 2017; 90:20170197 | 8 (2 hematologic) | Melanoma (2), neuroendocrine carcinoma, lung carcinoma, ovarian carcinoma (1), lymphomas (2) |
| Buisman et al.  | World J Surg Oncol. 2016;14:166 | 47 (18 hematologic) | Lymphoma (18), melanoma (11), ovary (6), lung (6), colon (3), kidney (1), stomach (1), and chorion (1). |
| Mirrielees et al.  | J Surg Res. 2014;188:419-31 | 31 (systematic review) | Non-small cell lung carcinoma |
| Zhou et al.  | Zhonghua Bing Li Xue Za Zhi. 2014;43:231-5. | 28 | Lung adenocarcinoma (8), ovarian serous carcinoma (5), gastric carcinoma (3), rectal carcinoma (2), pancreatic neuroendocrine carcinoma (1), prostatic carcinoma (1), melanoma (4), rhabdomyosarcoma (3), malignant peripheral nerve sheath tumor (1). |
| Shah et al. | Gulf J Oncolog. 2014;1:40-5. | 26 | adenocarcinoma (13)squamous cell carcinoma (12)poorly differentiated carcinoma (1) |
| Bacchi et al.  | Arch Pathol Lab Med. 2013;137:41-9 | 13 | Melanoma (13) |
| DeLair DF et al.  | Mod Pathol. 2013;26:343-9 | 85 | Carcinoma (58%), melanoma (22%) and sarcoma (20%). |
| Rodríguez-Gil et al. | Diagn Cytopathol. 2012;40:297-304 | 7 | Melanoma, synovial sarcoma, alveolar rhabdomyosarcoma, mixed müllerian tumor, medullary carcinoma of thyroid, colonic adenocarcinoma, gastric adenocarcinoma |
| Surov A et al.  | Acad Radiol. 2011;18:565-74 | 51 | Radiologic characteristics of primary vs. metastatic cancers to the breast |
| Lee et al.  | J Surg Oncol. 2010;101:137-40 | 33 (4 hematologic) | Gastric carcinoma (8), lung (5), liver (2), colon (2), CUP (2), melanoma (2), cholangiocarcinoma, skin, heart, ovary, prostate, thyroid, trachea, soft tissue (1), lymphoma and thymus (4) |
| Kinkor et al.  | Ceska Gynekol. 2010;75:560-3. | 9 | melanoma (3), small cell carcinoma (2), carcinoma from salivary gland, ovary, kidney and prostate (1) |
| Sauer et al. | Cytojournal. 2010;7:10. | 36 | Lung (15/36 = 41.7%). In five cases (5/36 = 13.9%), the origin remained uncertain |
| Wood et al.  | Pathology. 2008;40:345-51. | 32 (5 hematologic) | Cutaneous melanoma (10), lung (8), non-Hodgkin's lymphoma (5), soft tissue (4), colon (2), endometrium, ovary and bladder. |
| Fulciniti et al. | Ann Oncol. 2008;19:682-7 | 9 | Ovary (3), melanoma (2), endocervix (1), endometrium (1), lung (1) and prostate (1). |
| Williams et al.  | Cancer. 2007;110:731-7. | 169 | Melanoma/skin (67), respiratory (41), gynecologic (24), gastrointestinal (12), head and neck (9), genitourinary (68), sarcoma (6), other (2) |
| Lee  | J Clin Pathol. 2007;60:1333–1341. | 18 | Lung (5), ovary (4), melanoma (4), GEJ, kidney, thyroid, prostate (1), leiomyosarcoma, ovary (1) |
| Vaughan et al.  | World J Surg Oncol. 2007;5:74. | 18 | ovary (3), melanoma (6), medullary thyroid (3) pulmonary neuroendocrine, pulmonary small cell, oral squamous cell, and renal cell (1) |
| Ribeiro-Silva A et al.  | Pol J Pathol. 2006;57:161-5. | 12 (6 hematologic) | non-Hodgkin diffuse large B-cell lymphoma (3), acute myeloid leukemia (3), serous papillary adenocarcinoma, well-differentiated adenocarcinoma, squamous cell carcinoma, undifferentiated neoplasm, mesothelioma, and melanoma (1 each) |
| Loffeld et al.  | Br J Dermatol. 2005; 152:1206-10. | 8 | Melanoma (8) |
| Kurul et al.  | Jpn J Clin Oncol. 2005;35:202-6 | 12 | Melanoma (12) |
| Smymiotis et al.  | Eur J Gynaecol Oncol. 2005;26:547-50 | 7 (4 hematologic) | renal carcinoma, melanoma, leiomyosarcoma (1), lymphoma/leukemia (4) |
| Yeh et al.  | Am Surg. 2004;70:287-90. | 15 | hepatocellular carcinomas (3), gastric carcinomas (2), melanomas (2), colon carcinoma, lung adenocarcinoma, ovarian carcinoma, uterine leiomyosarcoma, nasopharyngeal carcinoma, esophageal squamous carcinoma, embryonal rhabdomyosarcoma, and cervical carcinoma (1) |
| Georgiannos et al.  | Cancer. 2001;92:2259-66. | 60 | Esophagus, retina, pancreas, thyroid, skin (most common). Other primary tumor sites included the stomach, lungs, and kidney |
| Cangiarella et al.  | Cancer. 1998;84:160-2 | 7 | Melanoma (7) |
| Moore et al.  | J Am Coll Surg. 1998;187:178-81. | 10 | Gynecologic cancers: ovarian (5), cervix (2), vagina, endometrium, peritoneum (1) |
| Vergier et al.  | J Surg Oncol. 1991;48:112-6. | 8 | Melanomas (3), rhabdomyosarcomas (2), mesothelioma, appendiceal carcinoid, and epidermoid cervical carcinoma (1) |
| Amichetti et al.  | Oncology. 1990;47:257-60. | 12 | melanoma (5), ovarian cancer (3)kidney cancer (1) |
| Sneige et al.  | Am J Clin Pathol. 1989;92:27-35. | 20 (3 hematologic) | Lung carcinoma (9), melanoma (3), carcinoid (2), ovarian, urothelial carcinoma (1), rhabdomyosarcoma (1), lymphoma/myeloma (3)  |
| Nielsen et al. | Acta Pathol Microbiol Scand A. 1981;89:251-6 | 15 | Melanoma (4), lung carcinoma (3), thyroid (2), colon (2), stomach, esophagus, kidney and ileal carcinoid (1) |
| Toombs et al.  | AJR Am J Roentgenol. 1977;129:673-6. | 21 (2 hematologic) | Melanoma (11), lung carcinoma (4), head and neck (2), stomach (1), fibrosarcoma (1), lymphoma (2) |

**Supplemental Table 1.** An overview of the previously published studies reporting metastatic cancers to the breast.

**Note**: A review of Koch et al. ([Gynecol Obstet Fertil.](https://www.ncbi.nlm.nih.gov/pubmed/24183577%22%20%5Co%20%22Gynecologie%2C%20obstetrique%20%26%20fertilite.) 2013;41:653-9) summarized the findings from 54 studies (2003-2012) reporting 463 cases of metastases to the breast. 29.8% of all metastases were from melanomas following by lung, gyneco-, GI- and hematologic malignancies.

None of these studies explored the molecular features of the secondary cancers to the breast in regards to immuno-oncology (I-O) and targeted therapies.