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**Intestinal metastasis from breast cancer: Presentation, treatment and survival from a systematic literature review**

Bolzacchini E *et al*. Intestinal metastasis from breast cancer

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**Abstract**

BACKGROUND

Intestinal metastases from breast cancer (BC) arerare; available data depend mainly on case reports and case series.

AIM

To conduct a review of the literature regarding presentation, diagnosis, treatment and survival of patients with intestinal metastasis from BC.

METHODS

We identified all articles that described patients with intestinal metastasis (from duodenum to anum) from BC using MEDLINE (1975 to 2020) and EMBASE (1975 to 2020) electronic databases.

RESULTS

We found 96 cases of intestinal metastasis of BC. Metastasization involved large bowel (cecum, colon, sigmoid, rectum) (51%), small bowel (duodenum, jejunum, ileum) (49%), and anum (< 1%). Median age of patients was 61-years. The most frequent histology was infiltrating lobular carcinoma followed by infiltrating ductal carcinoma. In more than half of patients, the diagnosis was made after the diagnosis of BC (median: 7.2 years) and in many cases of emergency, for bowel obstruction, bleeding or perforation. Diagnosis was achieved through endoscopy, radiological examination or both. In most of the cases, patients underwent surgery with or without systemic therapies. Survival of patients included in this review was available in less than 50% of patients and showed an overall median of 12 mo since diagnosis of the intestinal metastasis.

CONCLUSION

Although, intestinal metastases of BC are considered a rare condition, clinicians should consider the possibility of intestinal involvement in case of abdominal symptoms even in acute setting and many years after the diagnosis of BC, especially in patients with a histology of lobular carcinoma.

**Key Words:** Breast cancer; Intestinal metastasis; Diagnosis; Treatment; Small bowel; Large bowel

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**Core Tip:** We conducted a review of the literature regarding presentation, diagnosis, treatment and survival of patients with intestinal metastasis from breast cancer (BC). Although intestinal metastases of BC are considered a rare condition, several cases are reported from the available literature. Clinicians should consider the possibility of intestinal involvement in case of abdominal symptoms even in acute setting and many years after the diagnosis of BC.

**INTRODUCTION**

Breast cancer (BC) is the most common malignancy among women and a leading cause of cancer-related deaths[1,2]. In case of early diagnosis and application of new therapies, approximately 30% of patients are still at risk of developing distant metastasis, while 5% of the cases are metastatic at diagnosis[3]. The most common metastatic sites of BC are bones, lungs, liver and brain[4]. Gastrointestinal (GI) tract metastases are uncommon, detected in less than 5% of all BC patients[5]. Distinguishing primary and secondary GI cancer tumors can be clinically challenging. In particular, intestinal metastases from BC are rare, and related symptoms are not specific and often attributed to oncologic treatment, the main problem is to recognize them promptly and discriminate peritoneal carcinomatosis from other GI diseases to avoid any diagnostic delay and establish an effective treatment as soon as possible to improve survival of patients[6].

Despite well-known potential of intestinal metastatization of the BC, available data rely mainly on case reports and case series. Therefore, we report a literature review on presentation, diagnosis, treatment and survival of patients with intestinal metastasis from BC.

**MATERIALS AND METHODS**

We identified all articles that described patients with intestinal metastasis (from duodenum to anum) from breast cancer using MEDLINE (1975 to 2020) and EMBASE (1975 to 2020) electronic databases.

The search strategy was developed with a language restriction (only English texts) and literature search performed by applying the words: “Breast cancer”, “gastrointestinal metastasis”, “gastrointestinal tract”, “intestine, bowel”, “duodenum”, “jejunum, cecum”, “ileum”, “small bowel”, “large bowel”, “colon”, “sigma”, “sigmoid tract”, “rectum”, “anus” using the following string [(breast) AND (cancer or tumor or neoplasm) AND [duodenal neoplasms (secondary) OR jejunal neoplasms (secondary) OR cecal neoplasms (secondary) OR ileal neoplasm (secondary), OR small bowel neoplasm (secondary), OR colorectal neoplasms (secondary) OR sigma OR sigmoid neoplasm (secondary) OR anal neoplasms (secondary) NOT review], and filtering them for English studies and for humans studies (Figure 1).

The research of the literature was performed independently by two investigators (Nigro O and Bolzacchini E).

Studies were included if they met the following criteria: (1) Patients ≥ 18 years; (2) Patients with intestinal metastasis from breast cancer; and (3) Diagnosis of intestinal metastasis was objectively confirmed (histology).

Two investigators (Nigro O and Bolzacchini E) independently extracted data on study (year of publication, study centre), patients’ characteristics (number of subjects studied, age, gender), tumour’s characteristics (histology, time and site of metastatization), clinical presentation (main symptoms reported) as well as treatment and survival from the diagnosis of intestinal metastasis. We tried to contact the authors of the articles with missing survival data.

**RESULTS**

We identified 96 cases (86 articles) of intestinal metastases from BC[5-91]. Metastases are described in all parts of the intestinal tract, from the duodenum to the anum. Site of metastasis, presentation symptoms, treatment and clinical data are reported in Table 1.

Metastatization arose in large bowel (cecum, colon, sigmoid, rectum) (50/96; 52%), small bowel (duodenum, jejunum, ileum) (47/96; 49%), and anum (4/96, < 1%). Four patients presented multiple sites of intestinal metastases (small and large bowel); in three patients, gastric metastasis was also found, while peritoneum was also involved in six patients. Median age of patients was 61-years (between 31 and 88-years-old); only two patients were males. Histology comprehended lobular carcinoma (56/96; 58%), ductal carcinoma (17/96, 18%), phyllodes tumor (3), tubular carcinoma (1), or mixed histology (6).; 13/96 histologies were unknown. Intestinal involvement was diagnosed after the diagnosis of BC in 59/96 patients (median time; 7.2 years; range: 3 mo-25 years); the diagnosis was concomitant in 20/96 patients, in one case, the diagnosis of BC was made months after the metastatic involvement of the intestine and in another case, BC remained occult. In many cases, the diagnosis was made in emergency, for bowel obstruction (39 patients, 40.6%), bleeding (10 patients, 10.4%) and perforation (2 patients, 2%). Other patients complained of symptoms such as pain, changes in bowel habits, and in few patients, the diagnosis was incidental.

Diagnosis was achieved through endoscopy (esophagogastroduodenoscopy, colonoscopy or video capsule enteroscopy) in 54/96 cases (56.2%), radiological examination [computed tomography (CT), magnetic resonance imaging, barium enema or positron emission tomography (PET)] in 82/96 cases (85.4%) or both endoscopy and radiological imaging in 44/96 cases (45%).

In most of the cases, patients underwent surgery (69/96; 72%), with or without systemic therapies. The other patients started or continued medical therapy (18/96, 18.7%) such as hormone therapy and chemotherapy.

Specifically, 40 patients received hormone therapy (one patient aromatase inhibitor plus palbociclib), 38 patients received chemotherapy and 9 patients received both. Chemotherapy prescribed included monotherapy agents such as taxane-based chemotherapy (paclitaxel, docetaxel), anthracycline-based and oral fluoropyrimidine. Moreover, chemotherapy regimen was not specified in many reports.

Median overall survival of patients included in this review was available for 46/96 pts (< 50%); median survival estimated from the available data was around 12 mo.

**DISCUSSION**

Intestinal metastases from BC are rare. Jain *et al*[92] in a large study examined 1238 patients with operable BC and identified metastatic sites. They found that infiltrating ductal carcinoma recurred more often in the lung, pleura and bone, while infiltrating lobular carcinoma metastasized more often to bone marrow and peritoneum. Bone involvement as the initial presentation of distant metastatic disease occurred in over 50% of the women with infiltrating lobular carcinoma, significantly more often than in those with ductal infiltrating carcinoma (34%; *P* < 0.01). Survival was similar for the 2 groups.

Interestingly, metastatic disease to the extrahepatic GI tract from breast carcinoma usually originates from the lobular carcinoma subtype, which accounts for only 8% to 14% of all breast adenocarcinomas, rather than the more common invasive ductal carcinoma[93]. This could be related to a particular tropism of lobular cells. In a large autopsy series[94] of 337 patients who died of BC, GI metastasis presented an incidence of 16.4 % and only 20% of these patients complained of having symptoms. However, in this autopsy series, gastric and intestinal metastases were grouped, preventing an accurate estimation of the latter.

It has been well documented that recurrence in lobular BC can occur several years after the initial diagnosis of BC, even in early stage tumors. Recurrences of lobular BC have been reported up to 30 years from the initial time of diagnosis[95]. Accurate incidence of GI metastasis is hard to establish.

Symptoms depending on metastatic sites are generally not specific and may include abdominal pain, dyspepsia and nausea, acute symptoms such as bowel occlusion and GI bleeding may occur in most cases. Time interval between primary BC cases is wide, mostly years after the first diagnosis but rarely even before.

Endoscopy, radiological exams and histological evaluation are necessary to differentiate primary GI carcinoma from metastatic GI lesion of BC[32].

Endoscopic findings vary significantly and may range from ulcers, mucosal thickening or friability, linitisplastica-like inflammation, stenosis and polyps, to obstructing mass[24]. Barium studies reveal stricture or linitisplastica[41].

CT is indicated for characterizing the extension of the mass and for the re-staging[96]. Recently, Laoutliev *et al*[9] suggested that 18F-fluorodeoxyglucose PET should be considered.

Markers are generally not useful nor specific for the diagnosis of intestinal metastasis, but in an interesting case report by Santini *et al*[8] an increase in CA19.9 was used to diagnose ileocaecal valve metastasis from BC.

Differentiation of breast metastasis from other GI primaries can be difficult and immunohistochemistry is crucial to establishing the accurate diagnosis. Commonly used markers include estrogen receptors and progesterone receptors, CK7, CK20. A CK7-/CK20+ profile favors a large bowel primary, while CK7+/CK20- favors a metastasis[74].

GCDFP-15 and mammaglobin positivity was found to be sensitive and specific markers were used to differentiate a malignant lesion as a metastatic breast carcinoma, with an excellent correlation between GCDFP-15 and mammaglobin positivity and the origin of a metastatic BC[97,98]. It is very important to clarify the diagnosis since the treatment strategy for GI metastasis of BC and for primary GI carcinoma is totally different[99].

However, data on treatment are fragmentary. Surgical treatment, often palliative, should be reserved in case of emergencies (perforation, obstruction and hemorrhage), patients with isolated lesions, and selected cases in which tumor debunking could improve clinical outcome. Medical treatment such as chemotherapy, hormone therapy and anti HER2 therapy may be indicated depending on the biologic features of the primary disease and on prior therapy[100] and it is recommended as first-line treatment in case of multiple metastatic involvement. These therapies can be extremely effective and may help to avoid unnecessary surgery[10]. Radiotherapy is an option in case of anal localization[26,57] and in case of brain metastases[33] or bone metastases.

Long term outcome remains uncertain due to data scarcity and for the rareness of the condition. Nevertheless, some cases of longer survival were also reported[6,30]. Considering the available data, intestinal involvement seems prognostically unfavorable; in fact, progression free survival and overall survival of patients affected with metastatic BC have improved over the years thanks to the new treatment options.

We are aware that this review includes a selection bias as it does not rely on consecutive series of patients, but on many selected single case reports, published in English over a wide lag time (30 years). Therefore, many cases may not have been reported, several clinical data are missing and the outcome is especially not available for many cases even though we tried to contact the authors.

We pointed out that our review includes cases published from 1975 till date and clinical presentation, diagnosis and therapy might have changed over the years with awareness and technological advancement, nuclear medicine and new therapies. In this regard, a tentative analysis to assess the influence of time on several diagnostic and prognostic variables has been performed (data not shown), but no significant difference was found.

Nevertheless, the strength of our paper is its originality and the systematic methodological approach to the literature regarding intestinal localization of metastatic BC. Several reviews have already been published regarding gastric metastasis of BC; but to the best of our knowledge this is the first regarding intestinal involvement. Our paper comprehends all the cases reported so far in English language and summarizes epidemiology, symptoms, diagnostic work-up, therapy and survival of this condition. On this note, an estimate of the problem is given to the best of its knowledge and it forms the basis for the creation of a multicentre prospective study or a registry, which is the best option to investigate this uncommon but relevant issue of BC.

**CONCLUSION**

Clinicians should consider the possibility of intestinal involvement in case of abdominal symptoms, especially in patients with a histology of lobular carcinoma. Adequate imaging and endoscopic procedure should be performed promptly in order to obtain histological diagnosis. Treatment strategies include surgery, chemotherapy, hormone therapy and radiotherapy. Long term prognosis remains uncertain.

A multicenter study or registry study is required.

**ARTICLE HIGHLIGHTS**

***Research background***

Intestinal metastasis from breast cancer (BC) is considered rare.

***Research motivation***

We conducted a review of the literature regarding intestinal metastasis from BC.

***Research objectives***

We conducted a review of the literature regarding presentation, diagnosis, treatment and survival of patients with intestinal metastasis from BC.

***Research methods***

We identified all articles that described patients with intestinal metastasis from BC using MEDLINE and EMBASE electronic databases until 2020.

***Research results***

We found 96 cases of intestinal metastasis of BC.Metastasization involved large bowel in 51% of the cases, small bowel in 49% of the cases, and anum in less than 1%. Median age of patients was 61-year-old. The most frequent histology was infiltrating lobular carcinoma followed by infiltrating ductal carcinoma. In more than half of patients the diagnosis was made after the diagnosis of BC and in many cases in emergency setting, for bowel obstruction, bleeding or perforation. Diagnosis was achieved through endoscopy, radiological examination or both. In most of the cases patients underwent surgery with or without systemic therapies.

***Research conclusions***

Although intestinal metastases of BC are considered a rare condition, several cases are reported from the available literature.

***Research perspectives***

Our paper comprehends summarizes epidemiology, symptoms, diagnostic work-up, therapy and survival of this condition. On this account it gives an estimate of the problem and could lead to and represent the basis for the creation of a multicentre prospective study or a registry.

**REFERENCES**

1 **DeSantis CE**, Ma J, Gaudet MM, Newman LA, Miller KD, Goding Sauer A, Jemal A, Siegel RL. Breast cancer statistics, 2019. *CA Cancer J Clin* 2019; **69**: 438-451 [PMID: 31577379 DOI: 10.3322/caac.21583]

2 **Dafni U**, Tsourti Z, Alatsathianos I. Breast Cancer Statistics in the European Union: Incidence and Survival across European Countries. *Breast Care (Basel)* 2019; **14**: 344-353 [PMID: 31933579 DOI: 10.1159/000503219]

3 **Redig AJ**, McAllister SS. Breast cancer as a systemic disease: a view of metastasis. *J Intern Med* 2013; **274**: 113-126 [PMID: 23844915 DOI: 10.1111/joim.12084]

4 **Jin L**, Han B, Siegel E, Cui Y, Giuliano A, Cui X. Breast cancer lung metastasis: Molecular biology and therapeutic implications. *Cancer Biol Ther* 2018; **19**: 858-868 [PMID: 29580128 DOI: 10.1080/15384047.2018.1456599]

5 **Schwarz RE**, Klimstra DS, Turnbull AD. Metastatic breast cancer masquerading as gastrointestinal primary. *Am J Gastroenterol* 1998; **93**: 111-114 [PMID: 9448188 DOI: 10.1111/j.1572-0241.1998.111\_c.x]

6 **Ambroggi M**, Stroppa EM, Mordenti P, Biasini C, Zangrandi A, Michieletti E, Belloni E, Cavanna L. Metastatic breast cancer to the gastrointestinal tract: report of five cases and review of the literature. *Int J Breast Cancer* 2012; **2012**: 439023 [PMID: 23091732 DOI: 10.1155/2012/439023]

7 **Lau LC**, Wee B, Wang S, Thian YL. Metastatic breast cancer to the rectum: A case report with emphasis on MRI features. *Medicine (Baltimore)* 2017; **96**: e6739 [PMID: 28445295 DOI: 10.1097/MD.0000000000006739]

8 **Santini D**, Altomare A, Vincenzi B, Perrone G, Bianchi A, Rabitti C, Montesarchio V, Esposito V, Baldi A, Tonini G. An increase of CA 19.9 as the first clinical sign of ileocecal valve metastasis from breast cancer. *In Vivo* 2006; **20**: 165-168 [PMID: 16433047]

9 **Laoutliev B**, Harling H, Neergaard K, Simonsen L. Rectal metastasis from infiltrating lobular breast carcinoma: imaging with 18F-FDG PET. *Eur Radiol* 2005; **15**: 186-188 [PMID: 15449014 DOI: 10.1007/s00330-004-2394-1]

10 **Yanagisawa K**, Yamamoto M, Ueno E, Ohkouchi N. Synchronous rectal metastasis from invasive lobular carcinoma of the breast. *J Gastroenterol Hepatol* 2007; **22**: 601-602 [PMID: 17376062 DOI: 10.1111/j.1440-1746.2006.04671.x]

11 **Abdalla S**, Macneal P, Borg CM. Metastases of lobular breast carcinoma in the terminal ileum and ileocaecal valve. *J Surg Case Rep* 2015; **2015** [PMID: 25802254 DOI: 10.1093/jscr/rjv028]

12 **Bamias A**, Baltayiannis G, Kamina S, Fatouros M, Lymperopoulos E, Agnanti N, Tsianos E, Pavlidis N. Rectal metastases from lobular carcinoma of the breast: report of a case and literature review. *Ann Oncol* 2001; **12**: 715-718 [PMID: 11432633 DOI: 10.1023/a:1011192827710]

13 **Balakrishnan B**, Shaik S, Burman-Solovyeva I. An Unusual Clinical Presentation of Gastrointestinal Metastasis From Invasive Lobular Carcinoma of Breast. *J Investig Med High Impact Case Rep* 2016; **4**: 2324709616639723 [PMID: 27088099 DOI: 10.1177/2324709616639723]

14 **Yim K**, Ro SM, Lee J. Breast cancer metastasizing to the stomach mimicking primary gastric cancer: A case report. *World J Gastroenterol* 2017; **23**: 2251-2257 [PMID: 28405154 DOI: 10.3748/wjg.v23.i12.2251]

15 **Black M**, Hakam A, Harris C. Metastatic breast carcinoma uncovered in an otherwise unremarkable “random colon biopsy”. *Human Pathol Case Rep* 2016; **4**: 23-31 [DOI: 10.1016/j.ehpc.2015.07.004]

16 **Ng CE**, Wright L, Pieri A, Belhasan A, Fasih T. Rectal metastasis from Breast cancer: A rare entity. *Int J Surg Case Rep* 2015; **13**: 103-105 [PMID: 26188979 DOI: 10.1016/j.ijscr.2015.06.023]

17 **Jones C**, Tong AW, Mir M, Coyle Y. Lobular carcinoma of the breast with gastrointestinal metastasis. *Proc (Bayl Univ Med Cent)* 2015; **28**: 50-53 [PMID: 25552798 DOI: 10.1080/08998280.2015.11929185]

18 **Andriola V**, Piscitelli D, De Fazio M, Altomare DF. Massive colonic metastasis from breast cancer 23 years after mastectomy. *Int J Colorectal Dis* 2015; **30**: 427-428 [PMID: 25129525 DOI: 10.1007/s00384-014-1992-x]

19 **Osaku T**, Ogata H, Magoshi S, Kubota Y, Saito F, Kanazawa S, Kaneko H. Metastatic nonpalpable invasive lobular breast carcinoma presenting as rectal stenosis: a case report. *J Med Case Rep* 2015; **9**: 88 [PMID: 25902937 DOI: 10.1186/s13256-015-0568-x]

20 **Gizzi G**, Santini D, Guido A, Fuccio L. Single colonic metastasis from breast cancer 11 years after mastectomy. *BMJ Case Rep* 2015; **2015**: bcr2015211193 [PMID: 26150650 DOI: 10.1136/bcr-2015-211193]

21 **Khairy S**, Azzam A, Mohammed S, Suleman K, Khawaji A, Amin T. Duodenal Obstruction as First Presentation of Metastatic Breast Cancer. *Case Rep Surg* 2015; **2015**: 605719 [PMID: 26266075 DOI: 10.1155/2015/605719]

22 **Wang G**, Wang T, Jiang J, Zhou L, Zhao H. Gastrointestinal tract metastasis from tubulolobular carcinoma of the breast: a case report and review of the literature. *Onco Targets Ther* 2014; **7**: 435-440 [PMID: 24672246 DOI: 10.2147/OTT.S57831]

23 **Shakoor MT**, Ayub S, Mohindra R, Ayub Z, Ahad A. Unique presentations of invasive lobular breast cancer: a case series. *Int J Biomed Sci* 2014; **10**: 287-293 [PMID: 25598762]

24 **Zhang B**, Copur-Dahi N, Kalmaz D, Boland BS. Gastrointestinal manifestations of breast cancer metastasis. *Dig Dis Sci* 2014; **59**: 2344-2346 [PMID: 24748230 DOI: 10.1007/s10620-014-3155-x]

25 **Venturini F**, Gambi V, Di Lernia S, Vanzulli A, Bramerio M, Bencardino K, Amatu A, Cipani T, Forti E, Tarenzi E, Sartore-Bianchi A, Pugliese R, Siena S. Linitis Plastica of the Rectum As a Clinical Presentation of Metastatic Lobular Carcinoma of the Breast. *J Clin Oncol* 2016; **34**: e54-e56 [PMID: 24982453 DOI: 10.1200/JCO.2013.50.6733]

26 **Nair MS**, Phillips BL, Navaratnam R, Fafemi O. Anorectal metastasis from breast carcinoma. *J Gastrointest Cancer* 2013; **44**: 106-107 [PMID: 23397574 DOI: 10.1007/s12029-012-9435-9]

27 **Lv L**, Zhao Y, Liu H, Peng Z. Case report of small bowel obstruction caused by small intestinal metastasis of bilateral breast cancer. *Exp Ther Med* 2013; **6**: 675-678 [PMID: 24137245 DOI: 10.3892/etm.2013.1220]

28 **Maekawa H**, Fujikawa T, Tanaka A. Successful laparoscopic investigation and resection of solitary colonic metastasis from breast cancer (with video). *BMJ Case Rep* 2012; **2012** [PMID: 23152180 DOI: 10.1136/bcr-2012-007187]

29 **Carcoforo P**, Raiji MT, Langan RC, Lanzara S, Portinari M, Maestroni U, Palini GM, Zanzi MV, Bonazza S, Pedriali M, Feo CV, Stojadinovic A, Avital I. Infiltrating lobular carcinoma of the breast presenting as gastrointestinal obstruction: a mini review. *J Cancer* 2012; **3**: 328-332 [PMID: 22866167 DOI: 10.7150/jca.4735]

30 **Rajan S**, Saeed M, Mestrah M. Ductal carcinoma of the breast metastasizing to the rectum. *J Surg Case Rep* 2012; **2012**: 12 [PMID: 24960140 DOI: 10.1093/jscr/2012.5.12]

31 **Gerova VA**, Tankova LT, Mihova AA, Drandarska IL, Kadian HO. Gastrointestinal metastases from breast cancer: report of two cases. *Hepatogastroenterology* 2012; **59**: 178-181 [PMID: 22251535 DOI: 10.5754/hge10681]

32 **Bochicchio A**, Tartarone A, Ignomirelli O, Latorre G, Cangiano R, Gallucci G, Coccaro M, Feudale E, Aieta M. Anal metastasis from breast cancer: a case report and review of the literature. *Future Oncol* 2012; **8**: 333-336 [PMID: 22409468 DOI: 10.2217/fon.12.9]

33 **Zhao R**, Li Y, Yu X, Yang W, Guo X. Duodenal metastasis from recurrent invasive lobular carcinoma of breast: a case report and literature review. *Int J Clin Oncol* 2012; **17**: 160-164 [PMID: 21638025 DOI: 10.1007/s10147-011-0258-7]

34 **Bilen MA**, Laucirica R, Rimawi MF, Nangia JR, Cyprus GS. Jejunal intussusception due to malignant phyllodes tumor of the breast. *Clin Breast Cancer* 2012; **12**: 219-221 [PMID: 22381472 DOI: 10.1016/j.clbc.2012.01.007]

35 **Calò PG**, Fanni D, Ionta MT, Medas F, Faa G, Atzori F. Jejunal obstruction caused by metastasis from an undiagnosed breast cancer: a case report. *Tumori* 2012; **98**: 89e-91e [PMID: 22825527 DOI: 10.1700/1125.12419]

36 **Campanile F**, Maurea S, Mainenti P, Corvino A, Imbriaco M. Duodenal involvement by breast cancer. *Breast J* 2012; **18**: 615-616 [PMID: 23110410 DOI: 10.1111/tbj.12034]

37 **Mistrangelo M**, Cassoni P, Mistrangelo M, Castellano I, Codognotto E, Sapino A, Lamanna G, Cravero F, Bianco L, Fora G, Sandrucci S. Obstructive colon metastases from lobular breast cancer: report of a case and review of the literature. *Tumori* 2011; **97**: 800-804 [PMID: 22322849 DOI: 10.1700/1018.11099]

38 **Kawasaki A**, Mimatsu K, Oida T, Kanou H, Kuboi Y, Fukino N, Amano S. Small intestinal perforation due to metastasis of breast carcinoma: report of a case. *Surg Today* 2011; **41**: 698-700 [PMID: 21533944 DOI: 10.1007/s00595-010-4345-6]

39 **Eljabu W**, Finch G, Nottingham J, Vaingankar N. Metastatic deposits of breast lobular carcinoma to small bowel and rectum. *Int J Breast Cancer* 2011; **2011**: 413949 [PMID: 22295221 DOI: 10.4061/2011/413949]

40 **Mouawad NJ**, Cleary RK. Small bowel obstruction as the primary presentation of undiagnosed metastatic lobular breast carcinoma. *Breast Dis* 2011; **33**: 35-40 [PMID: 21965304 DOI: 10.3233/BD-2010-0317]

41 **Saied A**, Bhati C, Sharma R, Garrean S, Salti G. Small bowel obstruction from breast cancer metastasis: a case report and review of the literature. *Breast Dis* 2011-2012; **33**: 183-188 [PMID: 21778579 DOI: 10.3233/BD-2010-0311]

42 **Cho DH**, Jeon YS, Choi MY, Lee SK, Kim SM, Hur SM, Koo MY, Bae SY, Choe JH, Kim JH, Kim JS, Nam SJ, Yang JH, Lee JE. Ileal metastasis of breast cancer in a patient with a BRCA2 gene mutation: report of a case. *Surg Today* 2011; **41**: 1665-1669 [PMID: 21969203 DOI: 10.1007/s00595-011-4503-5]

43 **Choi JE**, Park SY, Jeon MH, Kang SH, Lee SJ, Bae YK, Kim MK. Solitary small bowel metastasis from breast cancer. *J Breast Cancer* 2011; **14**: 69-71 [PMID: 21847398 DOI: 10.4048/jbc.2011.14.1.69]

44 **Okido M**, Seo M, Hamada Y, Kurihara S, Matsumoto K, Konomi H, Kato M, Ichimiya H. Metastatic breast carcinoma simulating linitis plastica of the colon: report of a case. *Surg Today* 2011; **41**: 542-545 [PMID: 21431489 DOI: 10.1007/s00595-009-4305-1]

45 **Critchley AC**, Harvey J, Carr M, Iwuchukwu O. Synchronous gastric and colonic metastases of invasive lobular breast carcinoma: case report and review of the literature. *Ann R Coll Surg Engl* 2011; **93**: e49-e50 [PMID: 21943448 DOI: 10.1308/147870811X582800]

46 **Amin AA**, Reddy A, Jha M, Prasad K. Rectal metastasis from breast cancer: an interval of 17 years. *BMJ Case Rep* 2011; **2011** [PMID: 22696719 DOI: 10.1136/bcr.01.2011.3683]

47 **Saranovic D**, Kovac JD, Knezevic S, Susnjar S, Stefanovic AD, Saranovic DS, Artiko V, Obradovic V, Masulovic D, Micev M, Pesko P. Invasive lobular breast cancer presenting an unusual metastatic pattern in the form of peritoneal and rectal metastases: a case report. *J Breast Cancer* 2011; **14**: 247-250 [PMID: 22031809 DOI: 10.4048/jbc.2011.14.3.247]

48 **Arrangoiz R**, Papavasiliou P, Dushkin H, Farma JM. Case report and literature review: Metastatic lobular carcinoma of the breast an unusual presentation. *Int J Surg Case Rep* 2011; **2**: 301-305 [PMID: 22096760 DOI: 10.1016/j.ijscr.2011.06.010]

49 **Kumano H**, Hozumi Y, Shiozawa M, Takehara M, Koizumi M, Sata N, Lefor AT, Yasuda Y. Recurrent invasive ductal carcinoma of the breast presenting as a metastasis to the duodenum with long-term survival. *Am Surg* 2011; **77**: e107-e108 [PMID: 21679619]

50 **Razzetta F**, Tassara E, Saro F, Sironi M, D'Ambrosio G. Rare abdominal metastases from occult lobular breast cancer: report of two cases. *Updates Surg* 2011; **63**: 129-133 [PMID: 21286894 DOI: 10.1007/s13304-011-0047-x]

51 **Koleilat I**, Syal A, Hena M. Metastatic male ductal breast cancer mimicking obstructing primary colon cancer. *Int J Biomed Sci* 2010; **6**: 66-70 [PMID: 23675178]

52 **Titi MA**, Anabtawi A, Newland AD. Isolated gastrointestinal metastasis of breast carcinoma: a case report. *Case Rep Med* 2010; **2010**: 615923 [PMID: 20592983 DOI: 10.1155/2010/615923]

53 **López Deogracias M**, Flores Jaime L, Arias-Camisón I, Zamacola I, Murillo Guibert J, Suescun García R, Querejeta Usabiaga J, Martínez García F. Rectal metastasis from lobular breast carcinoma 15 years after primary diagnosis. *Clin Transl Oncol* 2010; **12**: 150-153 [PMID: 20156785 DOI: 10.1007/S12094-010-0481-0]

54 **Ferrari AB**, Pulcini G, Gheza F, Vinco A, Manenti S, Cervi E, Villanacci V, Cervi G. Duodenal metastasis from male breast cancer: a case report and review of the literature. *J Med Case Rep* 2009; **3**: 8331 [PMID: 19830225 DOI: 10.4076/1752-1947-3-8331]

55 **Théraux J**, Bretagnol F, Guedj N, Cazals-Hatem D, Panis Y. Colorectal breast carcinoma metastasis diagnosed as an obstructive colonic primary tumor. A case report and review of the literature. *Gastroenterol Clin Biol* 2009; **33**: 1114-1117 [PMID: 19896312 DOI: 10.1016/j.gcb.2009.05.015]

56 **Kelly RJ**, Barrett C, Swan N, McDermott R. Metastatic phyllodes tumor causing small-bowel obstruction. *Clin Breast Cancer* 2009; **9**: 193-195 [PMID: 19661046 DOI: 10.3816/CBC.2009.n.033]

57 **Puglisi M**, Varaldo E, Assalino M, Ansaldo G, Torre G, Borgonovo G. Anal metastasis from recurrent breast lobular carcinoma: a case report. *World J Gastroenterol* 2009; **15**: 1388-1390 [PMID: 19294770 DOI: 10.3748/wjg.15.1388]

58 **Tang JY**, Rampaul RS, Cheung KL. The use of fulvestrant, a parenteral endocrine agent, in intestinal obstruction due to metastatic lobular breast carcinoma. *World J Surg Oncol* 2008; **6**: 128 [PMID: 19046426 DOI: 10.1186/1477-7819-6-128]

59 **Birla R**, Mahawar KK, Orizu M, Siddiqui MS, Batra A. Caecal metastasis from breast cancer presenting as intestinal obstruction. *World J Surg Oncol* 2008; **6**: 47 [PMID: 18471290 DOI: 10.1186/1477-7819-6-47]

60 **Nihon-Yanagi Y**, Park Y, Ooshiro M, Aoki H, Suzuki Y, Hiruta N, Kameda N, Katoh R. A case of recurrent invasive lobular carcinoma of the breast found as metastasis to the duodenum. *Breast Cancer* 2009; **16**: 83-87 [PMID: 18386118 DOI: 10.1007/s12282-008-0045-0]

61 **Tseng CH**, Wang WL, Lee TC, Lee TH, Wang HP. Ileal obstruction in a 73-year-old woman. *Gut* 2009; **58**: 741, 804 [PMID: 19433590 DOI: 10.1136/gut.2008.164913]

62 **Al-Qahtani MS**. Gut metastasis from breast carcinoma. *Saudi Med J* 2007; **28**: 1590-1592 [PMID: 17914525]

63 **Sato T**, Muto I, Hasegawa M, Aono T, Okada T, Hasegawa J, Makino S, Kameyama H, Tanaka R, Sekiya M. Breast signet-ring cell lobular carcinoma presenting with duodenal obstruction and acute pancreatitis. *Asian J Surg* 2007; **30**: 220-223 [PMID: 17638643 DOI: 10.1016/s1015-9584(08)60026-3]

64 **Uygun K**, Kocak Z, Altaner S, Cicin I, Tokatli F, Uzal C. Colonic metastasis from carcinoma of the breast that mimics a primary intestinal cancer. *Yonsei Med J* 2006; **47**: 578-582 [PMID: 16941751 DOI: 10.3349/ymj.2006.47.4.578]

65 **Asoglu O**, Karanlik H, Barbaros U, Yanar H, Kapran Y, Kecer M, Parlak M. Malignant phyllode tumor metastatic to the duodenum. *World J Gastroenterol* 2006; **12**: 1649-1651 [PMID: 16570365 DOI: 10.3748/wjg.v12.i10.1649]

66 **Nazareno J**, Taves D, Preiksaitis HG. Metastatic breast cancer to the gastrointestinal tract: a case series and review of the literature. *World J Gastroenterol* 2006; **12**: 6219-6224 [PMID: 17036400 DOI: 10.3748/wjg.v12.i38.6219]

67 **Signorelli C**, Pomponi-Formiconi D, Nelli F, Pollera CF. Single colon metastasis from breast cancer: a clinical case report. *Tumori* 2005; **91**: 424-427 [PMID: 16459641]

68 **Yoo JS**, Smith TJ, Ning SM, Lee MJ, Thomas PE, Yang CS. Modulation of the levels of cytochromes P450 in rat liver and lung by dietary lipid. *Biochem Pharmacol* 1992; **43**: 2535-2542 [PMID: 1632812 DOI: 10.1007/s10151-005-0235-0]

69 **Hsieh PS**, Yeh CY, Chen JR, Changchien CR. Ileocecal breast carcinoma metastasis. *Int J Colorectal Dis* 2004; **19**: 607-608 [PMID: 15480710 DOI: 10.1007/s00384-004-0612-6]

70 **Kobayashi T**, Shibata K, Matsuda Y, Tominaga S, Komoike Y, Adachi S. A case of invasive lobular carcinoma of the breast first manifesting with duodenal obstruction. *Breast Cancer* 2004; **11**: 306-308 [PMID: 15550851 DOI: 10.1007/BF02984554]

71 **Lottini M**, Neri A, Vuolo G, Testa M, Pergola L, Cintorino M, Guarnieri A. Duodenal obstruction from isolated breast cancer metastasis: a case report. *Tumori* 2002; **88**: 427-429 [PMID: 12487566]

72 **Daniels IR**, Layer GT, Chisholm EM. Bowel obstruction due to extrinsic compression by metastatic lobular carcinoma of the breast. *J R Soc Promot Health* 2002; **122**: 61-62 [PMID: 11989148 DOI: 10.1177/146642400212200118]

73 **Hata K**, Kitayama J, Shinozaki M, Komuro Y, Watanabe T, Takano T, Iwase S, Nagawa H. Intestinal perforation due to metastasis of breast carcinoma, with special reference to chemotherapy: a case report. *Jpn J Clin Oncol* 2001; **31**: 162-164 [PMID: 11386463 DOI: 10.1093/jjco/hye030]

74 **Cervi G**, Vettoretto N, Vinco A, Cervi E, Villanacci V, Grigolato P, Giulini SM. Rectal localization of metastatic lobular breast cancer: report of a case. *Dis Colon Rectum* 2001; **44**: 453-455 [PMID: 11289296 DOI: 10.1007/BF02234749]

75 **Yokota T**, Kunii Y, Kagami M, Yamada Y, Takahashi M, Kikuchi S, Nakamura M, Yamauchi H. Metastatic breast carcinoma masquerading as primary colon cancer. *Am J Gastroenterol* 2000; **95**: 3014-3016 [PMID: 11051411 DOI: 10.1111/j.1572-0241.2000.03238.x]

76 **Bar-Zohar D**, Kluger Y, Michowitz M. Breast cancer metastasizing to the rectum. *Isr Med Assoc J* 2001; **3**: 624-625 [PMID: 11519394]

77 **Shimonov M**, Rubin M. Metastatic breast tumors imitating primary colonic malignancies. *Isr Med Assoc J* 2000; **2**: 863-864 [PMID: 11344761]

78 **van Halteren HK**, Peters H, Gerlag PG. Large bowel mucosal metastases from breast cancer. *J Clin Oncol* 1998; **16**: 3711-3713 [PMID: 9817292 DOI: 10.1200/JCO.1998.16.11.3711]

79 **Clavien PA**, Laffer U, Torhost J, Harder F. Gastro-intestinal metastases as first clinical manifestation of the dissemination of a breast cancer. *Eur J Surg Oncol* 1990; **16**: 121-126 [PMID: 2157608]

80 **Hansen RM**, Lewis JD, Janjan NA, Komorowski RA. Occult carcinoma of the breast masquerading as primary adenocarcinoma of the small intestine. A case report. *J Clin Gastroenterol* 1988; **10**: 213-217 [PMID: 2843590 DOI: 10.1097/00004836-198804000-00023]

81 **Wang X**, Jin M, Ye Q, Wang M, Hu Y, Yang Y, Yang J, Cai J. Solitary duodenum metastasis from breast cancer with 8 years' latency: A case report. *Medicine (Baltimore)* 2018; **97**: e9550 [PMID: 29480844 DOI: 10.1097/MD.0000000000009550]

82 **Invento A**, Mirandola S, Pellini F, Pollini GP, Grigolato D. Breast cancer and gastrointestinal metastasis. A case report and review of the literature. *Ann Ital Chir* 2018; **89**: 153-156 [PMID: 29848817]

83 **Oh SJ**, Park SY, Kim JY, Yim H, Jung Y, Han SH. Small bowel obstruction from distant metastasis of primary breast cancer: a case report. *Ann Surg Treat Res* 2018; **94**: 102-105 [PMID: 29441340 DOI: 10.4174/astr.2018.94.2.102]

84 **Falco G**, Mele S, Zizzo M, Di Grezia G, Cecinato P, Besutti G, Coiro S, Gatta G, Vacondio R, Ferrari G. Colonic metastasis from breast carcinoma detection by CESM and PET/CT: A case report. *Medicine (Baltimore)* 2018; **97**: e10888 [PMID: 29794798 DOI: 10.1097/MD.0000000000010888]

85 **Numan L**, Asif S, Abughanimeh OK. Acute Appendicitis and Small Bowel Obstruction Secondary to Metastatic Breast Cancer. *Cureus* 2019; **11**: e4706 [PMID: 31355066 DOI: 10.7759/cureus.4706]

86 **Cherian N**, Qureshi NA, Cairncross C, Solkar M. Invasive lobular breast carcinoma metastasising to the rectum. *BMJ Case Rep* 2017; **2017** [PMID: 28775079 DOI: 10.1136/bcr-2016-215656]

87 **Liu M**, Zhang L, Guo L, Lv J, Shi W, Liu B. Intestinal metastasis from breast invasive ductal carcinoma after a long latency: case report and literature review. *Onco Targets Ther* 2018; **11**: 8599-8603 [PMID: 30584319 DOI: 10.2147/OTT.S180949]

88 **Schellenberg AE**, Wood ML, Baniak N, Hayes P. Metastatic ductal carcinoma of the breast to colonic mucosa. *BMJ Case Rep* 2018; **2018** [PMID: 29804074 DOI: 10.1136/bcr-2018-224216]

89 **Meekel JP**, Coblijn UK, Flens MJ, Muller S, Boer den FC. Small bowel obstruction caused by 18FDG-negative ileocecal metastasis of lobular breast carcinoma. *J Surg Case Rep* 2020; **2020**: rjaa167 [PMID: 32760483 DOI: 10.1093/jscr/rjaa167]

90 **Kobayashi M**, Tashima T, Nagata K, Sakuramoto S, Osaki A, Ryozawa S. Colorectal and gastric metastases from lobular breast cancer that resembled superficial neoplastic lesions. *Clin J Gastroenterol* 2021; **14**: 103-108 [PMID: 33159678 DOI: 10.1007/s12328-020-01285-3]

91 **Vande Berg P**, Fonseca S, Al-Awa A, Rezai Monfared M, Delande S, Chamlou R, Etogo-Asse FE, Van Maele P. A rectal metastasis of an unknown lobular breast carcinoma and its management. *Acta Gastroenterol Belg* 2020; **83**: 327-330 [PMID: 32603055]

92 **Jain S**, Fisher C, Smith P, Millis RR, Rubens RD. Patterns of metastatic breast cancer in relation to histological type. *Eur J Cancer* 1993; **29A**: 2155-2157 [PMID: 8297656 DOI: 10.1016/0959-8049(93)90053-i]

93 **Borst MJ**, Ingold JA. Metastatic patterns of invasive lobular versus invasive ductal carcinoma of the breast. *Surgery* 1993; **114**: 637-41; discussion 641-2 [PMID: 8211676]

94 **Asch MJ**, Wiedel PD, Habif DV. Gastrointestinal metastases from crcinoma of the breast. Autopsy study and 18 cases requiring operative intervention. *Arch Surg* 1968; **96**: 840-843 [PMID: 5647555 DOI: 10.1001/archsurg.1968.01330230148023]

95 **Benfiguig A**, Anciaux ML, Eugène CI, Benkémoun G, Etienne JC. [Gastric metastasis of breast cancer occurring after a cancer-free interval of 30 years]. *Ann Gastroenterol Hepatol (Paris)* 1992; **28**: 175-177 [PMID: 1444182]

96 **Kidney DD**, Cohen AJ, Butler J. Abdominal metastases of infiltrating lobular breast carcinoma: CT and fluoroscopic imaging findings. *Abdom Imaging* 1997; **22**: 156-159 [PMID: 9013524 DOI: 10.1007/s002619900161]

97 **Bhargava R**, Beriwal S, Dabbs DJ. Mammaglobin vs GCDFP-15: an immunohistologic validation survey for sensitivity and specificity. *Am J Clin Pathol* 2007; **127**: 103-113 [PMID: 17145637 DOI: 10.1309/TDP92PQLDE2HLEET]

98 **Wang Z**, Spaulding B, Sienko A, Liang Y, Li H, Nielsen G, Yub Gong G, Ro JY, Jim Zhai Q. Mammaglobin, a valuable diagnostic marker for metastatic breast carcinoma. *Int J Clin Exp Pathol* 2009; **2**: 384-389 [PMID: 19158935]

99 **Taal BG**, Peterse H, Boot H. Clinical presentation, endoscopic features, and treatment of gastric metastases from breast carcinoma. *Cancer* 2000; **89**: 2214-2221 [PMID: 11147591]

100 **Matsui M**, Kojima O, Kawakami S, Uehara Y, Takahashi T. The prognosis of patients with gastric cancer possessing sex hormone receptors. *Surg Today* 1992; **22**: 421-425 [PMID: 1421863 DOI: 10.1007/BF00308791]

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**Figure Legends**

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**Figure 1 Study identification and selection process.**

**Table 1 Demographic and clinical data of patients with intestinal metastasis from breast cancer**

|  |  |  |
| --- | --- | --- |
|  | ***n* (%)**  | **Median (range)** |
| **Year of publication**  |  |  |
| < 2000 | 5 (5.8) |
| 2001-2005 | 12 (13.9) |
| 2006–2010 | 18 (20.9) |
| 2011-2015 | 36 (41.8) |
| > 2016 | 15 (17.4) |
| **Age**  |  | 61 (31-88) |
| **Gender**  |  |  |
| Female | 94 (97.9) |
| Male | 2 (2.1) |
| **Breast cancer histology** |  |  |
| Lobular carcinoma | 56(58.3) |
| Ductal carcinoma | 17 (17.7) |
| Phyllodes tumor | 3 (0.3) |
| Tubular carcinoma | 1 (0.1) |
| Mixed histology | 6 (0.6) |
| Unknown | 13 (13.5) |
| **Time of the diagnosis** |  |  |
| After the diagnosis of breast cancer | 59 (61.4) |
| Concomitant | 20 (20.8) |
| Before | 1 (0.2) |
| Unknown | 16 (16.6)1 |
| **Time after the diagnosis of breast cancer (yr)** |  | 7.2 (3 mo-25 yr) |
| **Clinical presentation or main symptom at diagnosis** |  |  |
| Bowel obstruction | 39 (40.6) |
| Rectal bleeding | 10 (10.4) |
| Perforation | 2 (2) |
| Abdominal pain | 20 (20.8) |
| Change in bowel habit | 9 (9.3%) |
| Incidental | 12 (12.5) |
| Unknown | 4 (4.1) |
| **Site of metastatization**  |  |  |
| Colon | 45 (46.8) |
| Small bowel | 43 (44.8) |
| Colon and small bowel | 4 (4) |
| Anus | 4 (4) |
| **Diagnostic tool for the detection of the metastasis** |  |  |
| Endoscopy (EGDS or colonscopy or VCE) | 54 (56.2) |
| Radiography (CT scan, MRI, barium enema, PET) | 82 (85.4) |
| Unknown | 12 (12.5) |
| **Treatment** |  |  |
| Surgery and medical therapy | 69/96 (71.8) |
| Hormone therapy and/or chemotherapy | 18/96 (18.7) |
| **Survival after the diagnosis of metastasis (yr)**2 |  | 12 (1 mo-7 yr) |

1 In one case the primary tumor remained occult.

2Available for 46 patients. EGDS: Esophago-gastro-duodenoscopy; VCE: Video capsule endoscopy; CT: Computed tomography; MRI: Magnetic resonance imaging; PET: Positron emission tomography.



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