Hepatic resection for breast cancer related liver metastases: A single institution experience

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Abstract
Background & objective: Liver resection for breast cancer liver metastases is becoming a more widely accepted therapeutic option for selected groups of patients. The aim of this study was to describe the outcomes of patients undergoing liver resection for breast cancer-related liver metastases and identify any variables associated with recurrence or survival.

Methods: A retrospective review of a prospectively maintained database was undertaken for the 12-year period between 2009 and 2021. Clinicopathological, treatment, intraoperative, recurrence, survival and follow-up data were collected on all patients. Kaplan-Meier methods, the log-rank test and Cox proportional hazards regression analysis were used to identify variables that were associated with recurrence and survival.

Results: A total of 20 patients underwent 21 liver resections over the 12-year period. There were no deaths within 30 days of surgery and an operative morbidity occurred in 23.8% of cases. The median local recurrence free survival and disease free survival times were both 50 months, while the 5-year overall survival rate was 65%. The presence of extrahepatic metastases were associated with a decreased time to local recurrence ($p < 0.01$) and worse overall survival ($p = 0.02$).

Conclusions: This study has demonstrated that liver resection for breast cancer-related liver metastases is feasible, safe and associated with prolonged disease free and overall survival in selected patients. It is likely that this option will be offered to more patients going forward, however, the difficulty lies in selecting out those who will benefit from liver resection particularly given the increasing number of systemic treatments and local ablative methods available that offer good long-term results.

Keywords
Breast cancer, breast cancer liver metastases, hepatic resection, liver resection, metastatic disease, surgical oncology

Introduction
Breast cancer represents a significant global health problem and is currently the most frequently diagnosed cancer and leading cause of cancer death in females. There was an estimated 2,088,849 new cases of breast cancer and 626,679 deaths from the disease worldwide in 2018. A significant proportion of these patients will eventually develop distant metastases which
is associated with an extremely poor prognosis. Approximately 50% of patients with metastatic breast cancer will develop hepatic metastases and the life expectancy for this cohort of patients is significantly reduced with some studies demonstrating a median survival of 2–21 months and 5–year survival rates ranging from 3.8% to 12%, although this varies depending on several patient-related factors and tumor biology.2–4

The treatment paradigm for patients with metastatic breast cancer has undergone significant changes in recent decades. Cytotoxic chemotherapy has been complemented with or, in many cases, replaced by hormonal therapy, targeted therapy and more recently in selected cases, immunotherapy.5–7 There is emerging evidence regarding the role of surgery and ablative therapies for women with metastatic breast cancer confined to a single site, although, it is clear that only a small fraction of women with metastatic disease are suitable for this approach.8 A number of small retrospective studies have reported results for resection of breast cancer-related liver metastases (BCLM) reporting median survival times of 30–70 months and 5-year overall survival rates of 33%–50%.9,10 While resection of colorectal cancer liver metastases (CRCLM) is now the recommended gold standard for those with potentially resectable disease, there is still a lack of clarity and consensus on how best to treat those with potentially resectable BCLM.11 In particular, there are no completed randomized controlled trials comparing surgical resection of BCLM to best available systemic therapy although one such trial has commenced recruitment.12 There is however, a propensity score matching study demonstrating that surgery for BCLM yields a survival benefit compared to systemic therapy alone, particularly in patients with hormone receptor positive cancers.13 As many centers push ahead with surgical resection for BCLM we must ask ourselves which patients should be considered for this option and which patients should be spared the potential morbidity of liver resection and treated with systemic therapies instead.

The aim of this study was to describe the outcomes of the first series of patients in our institution to undergo hepatic resection for BCLM. Furthermore, we aimed to identify any clinicopathological variables that were associated with an increased risk of local recurrence in the liver or worse overall survival.

Methods
Study population and data collected

The study cohort consisted of a consecutive series of patients, all of whom underwent hepatic resection for BCLM in the 12-year period between January 31, 2009 and January 31, 2021. Patients were identified from an institutional review board approved, prospectively maintained, database. Data from the following demographic and clinicopathological categories were collected on all patients; age, date of diagnosis of primary breast cancer, date of resection of primary breast cancer, method of resection of primary breast cancer, American Joint Committee on Cancer (AJCC)/Union for International Cancer Control (UICC) stage (T, N, M) at the time of breast cancer diagnosis and pathological data from the primary breast cancer including hormone receptor status and HER2 status, the use of neoadjuvant and adjuvant therapy in the treatment of the primary breast cancer, local recurrence of breast cancer, date of diagnosis of liver metastases, date of resection of liver metastases, pathological data from liver metastases, resection margin status, presence of extrahepatic metastases at the time of diagnosis, preoperative and postoperative treatment of liver metastases, the use of alternative therapies such as ablation, ASA grade, operative approach, operating time, blood loss, need for blood transfusion, length of stay, postoperative morbidity, postoperative mortality, hepatic recurrence data, extrahepatic recurrence data and survival data. Synchronous disease was defined as the diagnosis of metastatic disease within 6 months of primary tumor resection.

Selection criteria

Any patient that underwent a liver resection for breast cancer liver metastasis performed during the study period and hence identifiable in our institutional database were selected for inclusion in this study. The eligibility criteria employed for metastasectomy included evaluation of the lesions with high resolution computed tomography (CT) and magnetic resonance imaging (MRI) to determine the probability of achieving an R0 resection. All potential cases were reviewed at a specialist hepatobiliary multidisciplinary team (MDT) conference that is attended by medical oncologists, radiologists, pathologists and hepatobiliary surgeons. Potential candidates needed to be deemed physiologically suitable for surgery. Suitable candidates needed to have a pattern of disease that was potentially fully resectable with single stage surgery and would leave an adequate future liver remnant. Selected patients with extrahepatic metastases were potentially eligible for liver resection if their extrahepatic disease was deemed to be fully treated or controlled (defined as at least 1-year of disease stability with no evidence of progression on imaging). Diagnosis of liver metastases was confirmed by histological analysis of a radiological guided biopsy. Perioperative chemotherapy, hormonal therapy and targeted therapy were administered on a case by case basis after discussion at the MDT and choices of therapy were based on tumor biology and patient characteristics. Patients typically remained on some form of lifelong systemic therapy according to their biological subtype as is standard in stage IV breast cancer.

Follow-up

Patients had a CT scan of their thorax, abdomen and pelvis 3 months after their liver resection and then every 3–4 months...
thereafter to look for evidence of local or distant recurrence. Local recurrence free survival (LRFS), disease-free survival (DFS) and overall survival (OS) were calculated from the date of liver resection and these analyses included only patients undergoing their first liver resection for BCLM. The most recent follow-up date or the date of death where applicable, were ascertained using inpatient hospital records, outpatient clinic dictations or outpatient imaging and phlebotomy appointment dates. General practitioners were contacted in some cases to determine the exact date of death. Local oncologists were also contacted in a small number of cases to determine the date of last follow-up and current disease status for several patients who were referred for surgery from outside our hospital catchment area.

Statistical analysis

Statistical analysis was carried out using GraphPad Prism version 9.0.0 and MedCalc version 20.008. Age at diagnosis, tumor size, number of metastases, operating time and blood loss are presented as mean +/- standard error of the mean (SEM). Interval from diagnosis of breast cancer to diagnosis of liver metastases and length of stay are presented as median with interquartile range (IQR). All other variables are presented as number and percentage of total cohort. A log-rank test was used to analyze LRFS, DFS and OS. Survival curves predicting the median time to local recurrence, the median DFS time, the median OS time and 5 year LRFS, DFS and OS rates from the time of hepatic resection were generated using the Kaplan-Meier method. Those with extrahepatic metastases prior to liver resection were excluded from the analysis on DFS. Cox proportional hazards regression analysis was used to identify any clinicopathological variables that were associated with hepatic recurrence or an increased risk of death. Two-tailed p values were computed and differences were considered statistically significant at p < 0.05.

Results

Pathological characteristics and treatment of primary breast cancer

We identified 20 female patients who underwent 21 hepatic resections for BCLM during the selected 12 year time period. A single patient underwent repeat hepatic resection after she developed recurrent liver disease 8 months after her first hepatic resection. The characteristics of the 20 patients and the characteristics of their primary breast cancer and the treatment they underwent is shown in Tables 1 to 3. The mean age at diagnosis of primary breast cancer was 49.0 (+/- 2.1) years. The majority of primary breast cancers were ductal or ductal mixed with another subtype (n=18 (90.0%) while the remainder (n=2 (10.0%) were lobular. The mean tumor size was 28.8 mm and lymphovascular invasion (LVI) was present in 14 cases (70.0%). Nodal disease was identified in 13 cases
Variable | n = 20 patients
--- | ---
Operation |  
WLE and SNLB | 6 (30.0%)  
WLE and ALND | 4 (20.0%)  
Mastectomy and ALND | 9 (45.0%)  
Primary tumor not resected | 1 (5.0%)  
Neoadjuvant therapy |  
Yes | 7 (35.0%)  
No | 12 (60.0%)  
Primary tumor not resected | 1 (5.0%)  
Adjuvant therapy |  
Yes | 17 (85.0%)  
No | 2 (10.0%)  
Primary tumor not resected | 1 (5.0%)  
Locoregional recurrence |  
Yes | 5 (25.0%)  
No | 14 (70.0%)  
Primary not resected | 1 (5.0%)  
Histology |  
Ductal/Mixed ductal | 18 (85.7%)  
Lobular | 2 (9.5%)  
Papillary | 1 (4.8%)  
Vascular invasion |  
Yes | 6 (28.6%)  
No | 15 (71.4%)  
Pathological complete response |  
Yes | 2 (9.5%)  
No | 19 (90.5%)  
Mean tumor size (± SEM) | 30.9 mm (± 3.2)  
Mean number of metastases (± SEM) | 1.6 (± 0.2)  
Bilobar metastases |  
Yes | 8 (38.1%)  
No | 12 (57.1%)  
Positive margins |  
Yes | 8 (38.1%)  
No | 12 (57.1%)  
Estrogen/Progesterone receptor positive |  
Yes | 17 (81.0%)  
No | 4 (19.0%)  
HER2 positive |  
Yes | 6 (28.6%)  
No | 15 (71.4%)  
Molecular Group |  
ER +/HER2-ve | 11 (52.4%)  
HER2 +/ER-ve or + ve | 6 (28.6%)  
TNBC | 3 (14.3%)  
Mixed biology (ER+/HER2-ve & TNBC) | 1 (4.8%)  

Table 2. Patient characteristics and pathological characteristics of liver metastases.

| Variable | n = 20 patients/21 resection |
| --- | --- |
| Mean age (± SEM) at time of diagnosis of liver metastasis | 53.4 years (± 2.6) |
| Median interval from diagnosis of breast cancer to diagnosis of liver metastasis | 34 months (IQR 13-46) |
| ASA grade |  
II | 15 (75.0%)  
III | 5 (25.0%)  
Liver metastasis present at time of breast cancer diagnosis |  
Yes | 4 (20.0%)  
No | 16 (80.0%)  
Extrahepatic metastases at time of resection |  
Yes—(Bone metastases in all) | 4 (20.0%)  
No | 16 (80.0%)  
Hepatic recurrence after resection |  
Yes | 9 (45.0%)  
No | 11 (55.0%)  

SEM: Standard error of the mean; HER2: Human epidermal growth factor receptor 2; ER: Estrogen receptor; TNBC: Triple negative breast cancer.

Hormone receptor positivity was identified in 17 cases (85.0%), while HER2 positivity was present in 6 cases (30.0%). Stage 4 disease was diagnosed in 4 cases (20.0%) at the time of primary breast cancer diagnosis and 5 patients (25.0%) were found to have liver metastases within 6 months of the primary breast cancer diagnosis. Mastectomy and axillary lymph node dissection (ALND) was the most common procedure (n = 9 (45.0%) among those patients who underwent surgery for their primary breast cancer. Negative (Continued)
Table 3. Operative data and treatment of liver metastases.

| Variable | n = 20 patients/21 resections |
|----------|-----------------------------|
| Operation |                             |
| Multisegmental resection | 9 (42.9%) |
| Segmentectomy | 5 (23.8%) |
| Right posterior sectionectomy | 2 (9.5%) |
| Left lateral sectionectomy | 2 (9.5%) |
| Left hepatectomy | 1 (4.8%) |
| Left hepatectomy & intraoperative RFA to 2nd lesion | 1 (4.8%) |
| Central hepatectomy | 1 (4.8%) |
| Surgical approach | |
| Open | 17 (81.0%) |
| Laparoscopic | 4 (19.0%) |
| Mean operating time (+/- SEM) | 174 mins (+/- 15) |
| Mean blood loss (+/- SEM) | 622 mL (+/- 100) |
| Intraoperative blood transfusion | |
| Yes | 1 (4.8%) |
| No | 20 (95.2%) |
| Median length of stay | 10 days (IQR 7-13) |
| 30 day mortality | |
| Yes | 0 (0.0%) |
| No | 21 (100.0%) |
| Liver specific morbidity | |
| Yes | 2 (9.5%) |
| No | 19 (90.5%) |
| Morbidity by Clavien Dindo grade | |
| Clavien Dindo grade 2 | 2 (9.5%) |
| Clavien Dindo grade 3 | 3 (14.3%) |
| Repeat resections for recurrence | 1 (5.0%) |
| Combined breast and liver resection | 1 (5.0%) |
| Preoperative therapy | |
| Yes | 17 (85.0%) |
| No | 3 (15.0%) |
| Postoperative therapy | |
| Yes | 20 (100.0%) |

RFA: Radiofrequency ablation; SEM: Standard error of the mean; IQR: Interquartile range.

Clinicopathological characteristics of liver metastases

The mean age at the time of diagnosis of BCLM was 53.4 (+/-2.6) years with a median interval of 34 months (interquartile range (IQR) 13-46) from the time of diagnosis of breast cancer to the time of diagnosis of liver metastases. The median interval from the time of diagnosis of liver metastasis to the time of liver resection was 6 months (IQR 1-13.5). The longest interval between diagnosis of the primary breast cancer and diagnosis of BCLM was 255 months. Four patients (20.0%) were diagnosed with BCLM at the time of diagnosis of their primary breast cancer and a fifth patient was diagnosed with BCLM within 6 months of diagnosis of their primary breast cancer. Extrahepatic metastases were diagnosed in 4 patients (20.0%) prior to liver resection and all 4 had bone metastases that were deemed to be controlled at the time of liver resection.

The histology from the liver metastases were found to be ductal or a mixed ductal variant in 18 cases (85.7%), lobular in 2 cases (9.5%) and papillary in a single case (4.8%). The mean tumor size was 30.9 mm (+/-3.2 mm) and the mean number of metastases was found to be 1.6 (+/- 0.2). Six patients (28.6%) had bilobar metastases. Vascular invasion was identified in 28.6% of cases and a pathological complete response to preoperative treatment was found in two cases (9.5%). A positive resection margin was identified in 6 cases (28.6%). Hormone receptor positivity was found in 17 cases (81.0%) and HER2 positivity was found in 6 cases (28.6%). One patient who had an ER + ve/HER2-ve primary breast cancer was found to have two liver metastases each with different receptor statuses. One of the metastases matched her primary breast cancer and was ER + ve/HER2-ve while the other was triple negative breast cancer (TNBC). A second patient had a HER2 + ve primary breast cancer and underwent resection of a liver metastasis that was HER2 + ve. She then developed recurrence in her liver and underwent repeat resection which was found to be TNBC.

Treatment of liver metastases

A single patient underwent combined breast and liver resection at the same time. The majority of liver resections (81.0%) were performed using an open approach. Resection of a single segment or multi-segmental resections were the most common procedures performed. A single patient underwent a left hepatectomy with intraoperative radiofrequency ablation (RFA) to treat a second lesion. The mean operating time was 174 (+/-15) minutes and the mean blood loss was 622 mL (+/-100 mL). Intraoperative blood transfusion was required.
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in only one case. The median length of stay (LOS) was 10 days (IQR 7-13). There were no deaths within 30 days of surgery. An operative morbidity was identified after 5 (23.8%) of the resections, two of these were liver specific morbidities. A single patient developed a urinary tract infection after catheterization which required treatment with intravenous (IV) antibiotics. One patient had an abdominal wall cellulitis and wound collection that was managed by removing skin clips and giving IV antibiotics. One patient had a large abdominal wall collection that required drainage by interventional radiology (IR) and IV antibiotics, they then developed an incisional hernia which required surgery. One patient had a liver abscess requiring drainage by IR and IV antibiotics. The final patient had a leak from their hepaticojejunostomy which was managed with a drain placed by IR and left in-situ for 8 weeks along with IV antibiotics. Preoperative and postoperative therapy were given to 17 (85.0%) patients and 20 (100.0%) patients before and after their liver resection respectively.

Recurrence and survival
The median follow-up time was 32 months (IQR 23-64.5). Local recurrence in the liver occurred in 9 patients (45.0%) during follow up, while 5 patients (25.0%) died during the follow up period. The median interval to hepatic recurrence was 50 months and the estimated 5 year LRFS rate was 44% (See Fig. 1(A)). The median DFS time was 50 months and the estimated 5 year DFS rate was 46% (See Fig. 1(B)). The median OS was undefined and the estimated 5 year OS rate was found to be 65% (See Fig. 1(C)).

Predictors of recurrence and survival
Multiple clinicopathological factors were analyzed to try and identify any that may be associated with hepatic recurrence after resection of BCLM (See Supplementary Table-1) or with death after resection of BCLM (See Supplementary Table-2).
Using the Cox proportional hazards regression analysis method, it was shown that the only significant factor was the presence of extrahepatic metastases before resection. The presence of extrahepatic metastases \((p < 0.01)\) prior to liver resection was found to be associated with a decreased time to hepatic recurrence (See Supplementary Figure-1). The presence of extrahepatic metastases \((p = 0.02)\) prior to liver resection was also found to be associated with worse overall survival after liver resection (See Supplementary Figure-2). The presence of de-novo metastases, HER2 status and molecular subgroups (ER \(+ve/HER2-ve\), HER2 \(+ve\) or triple negative breast cancer (TNBC) were deemed to be of significant interest and hence analyzed using the log-rank test and Kaplan-Meier methods to identify if any of these factors could predict hepatic recurrence or overall survival after liver resection. None of these factors were found to influence hepatic recurrence or survival after resection (See Supplementary Figure-3-6).

**Discussion**

This study has described the outcomes for 20 patients with BCLM who underwent a liver resection in our institution over a 12-year period. The results demonstrate that liver resection is feasible and has an acceptable safety profile for selected patients with BCLM. Furthermore, this study has demonstrated that some patients can achieve excellent long-term results after liver resection for BCLM, with a median interval to hepatic recurrence of 50 months and an estimated 5-year OS of 65\%. There is of course some selection bias as patients deemed suitable for liver resection were likely those with a pattern of disease and tumor biology that would have had an excellent prognosis with optimal medical management without surgery.\(^8\) One must also acknowledge the fact that only a minority of patients with metastatic breast cancer arrive at a point where they are deemed suitable for liver resection, demonstrated by the fact that only 20 patients were operated on over a 12-year period in our institution. This small number is consistent with several other previous studies.\(^{14-16}\) It may also be true that many patients with BCLM are not referred to specialist hepatobiliary centers for consideration for liver resection due to a lack of acceptance of liver resection as part of the treatment paradigm for BCLM. Our initial experience with liver resection for BCLM has highlighted some important findings. First, we included a small cohort of patients with extraphepatic metastases (all bone metastases) that were deemed to be controlled, as several studies had not identified this to be an important prognostic factor.\(^{13,15,17-20}\) In our cohort all 4 patients with a history of extraphepatic metastases prior to liver resection were found to have local recurrence in their liver within 7 months of undergoing surgery and were also found to have a significantly worse overall survival. Given that our numbers were small, the outcomes for this cohort of patients requires further investigation to determine if liver resection can provide them with any meaningful benefit. Second, we could not identify any association between other clinicopathological factors with recurrence or survival. This means that based on our findings, patients with multiple metastases, bilobar metastases and large metastases should still be considered as potential candidates for surgical resection.

There are many factors beyond surgery which will influence outcomes for patients with BCLM. One of the most important factors is tumor biology which includes but is not limited to hormone receptor status and HER2 status. Hormone receptor positive and HER2 positive tumors provide oncologists with clear molecular targets with multiple therapeutic agents available for these targets.\(^{21}\) With currently available treatments, patient with relapsed or de-novo metastatic HER2 positive breast cancer can achieve median survival times in excess of 57 months\(^3\) and there is some evidence to suggest that HER2 positive breast cancer with liver metastases can be cured with a combination of chemotherapy and anti-HER2 agents.\(^{22}\) It is worth noting that the two patients who had a complete response in their liver to preoperative treatment were both HER2 positive. Those patients with TNBC still present a therapeutic challenge and are known to have a poor prognosis.\(^{23}\) Our cohort had two patients with the TNBC subtype in their primary breast cancer, one of whom developed extrahepatic metastases after liver resection. A third patient was found to have TNBC in one of her two resected liver lesions despite the primary breast cancer being ER \(+ve/HER2-ve\) and she went on to develop local recurrence in her liver. Finally, a fourth patient with a HER2 \(+ve\) primary breast cancer and a HER2 \(+ve\) liver metastasis developed local recurrence in her liver after surgery requiring repeat resection and the recurrent lesion was found to be of the TNBC subtype. With such biological diversity the cohort of patients that are offered resection are extremely heterogeneous and this is shown not just by the biology of their tumors but also by the vastly different treatment regimens that each patient has completed by the time they make it to surgery. Several patients in our cohort have been treated with or are being considered for immunotherapy based on positive expression of programmed death-ligand 1 (PD-L1). Clearly comparisons of patients undergoing liver resection for BCLM is difficult when one considers the sheer number of confounding variables created by tumor biology and personalized approaches to treatment alone. Molecular subtype appears to influence outcomes after surgical resection, and patients with HER2-enriched subtypes have been shown to have prolonged overall survival after surgery compared with basal-like and luminal A subtypes.\(^{24}\)

Determining whether or not surgery for BCLM offers a survival benefit has proven difficult as there has never been a randomized controlled trial of surgery and optimal medical management versus optimal medical management alone. The BreCLIM-2 study comparing surgical intervention in the form of liver resection, ablation or stereotactic body radiotherapy with best oncological treatment to best
oncological treatment alone has commenced recruiting patients for randomization, however the recruitment period is expected to run until December 2029 and with the primary outcome being survival three years after randomization, we may not see results from this study until 2033. Furthermore, many studies focusing on surgical and medical management are confounded by the use of other techniques such as radiofrequency ablation, microwave ablation, stereotactic body radiotherapy and hepatic arterial infusion of chemotherapy. A propensity score matching study has demonstrated a survival benefit for patients undergoing liver resection, particularly for those with hormone receptor positive disease. Two case matched studies have demonstrated improved survival for patients undergoing liver resection with systemic treatment versus systemic treatment alone, although another case control study has shown no difference in progression free survival between those undergoing surgery and those receiving systemic treatment only. It seems plausible that a select cohort of patients will achieve a survival benefit from undergoing liver resection for BCLM and a recent meta-analysis has demonstrated a survival advantage for patients undergoing surgery combined with systemic therapy versus those receiving systemic therapy alone. Several other reviews have produced conflicting reports about the evidence of hepatic resection for BCLM. There is also some evidence that this is a cost-effective treatment option when compared with systemic therapy alone, particularly in those with hormone receptor positive tumors and when newer systemic agents are used. As the evidence for this therapeutic option increases we are beginning to see the boundaries being pushed further with new evidence suggesting that there may be a benefit in repeat liver resection for patients with recurrent liver disease after their first resection. This raises questions as to whether or not some patients with BCLM will be treated in a similar fashion to patients with CRCLM, some of whom undergo two stage hepatectomies with portal vein embolization in an effort to achieve long-term survival. There is also emerging evidence demonstrating that minimally invasive surgery is a safe and feasible option for patients undergoing hepatic resection for BCLM. The main limitations of this study are the fact that it is retrospective in nature and that the cohort of patients included is small and therefore highly selected. The small number of patients makes it difficult to ascertain if any clinicopathological factors are truly associated with recurrence or survival, although we did identify an association between extrahepatic disease with earlier local recurrence and worse overall survival. We believe these findings are biologically plausible and these factors should be considered at the MDT meeting when deciding whether or not to offer surgery. There is clearly selection bias with a study of this nature and it is likely that we have offered liver resection to patients who would have had reasonably good long-term outcomes with optimal systemic therapy alone. The main strength of the study was that we were able to gather complete clinicopathological, intraoperative, treatment and follow up data on all included patients.

Conclusions

There have been significant gains made in the management of patients with metastatic breast cancer in recent years, particularly for those with hormone receptor positive and HER2 positive disease. There are several options available for patients with BCLM including liver resection. This study has shown that liver resection is safe and feasible in a select group of patients with BCLM and that long-term disease free and overall survival can be achieved in many of these patients. While BCLM is a different disease to CRCLM, we are beginning to see more widespread use of liver resection for BCLM in a similar fashion to CRCLM, including the use of repeat resection for those with local recurrence.

Author contributions

Study concept and design—All authors Study Materials—All authors Data Collection—I.S. Reynolds Statistical Analysis—I.S. Reynolds Manuscript Preparation—All Authors Manuscript Review—All Authors

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Supplemental material

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