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RETRACTED: The value, diagnostic efficacy and clinical significance of functional magnetic resonance imaging in evaluating the efficacy of neoadjuvant chemotherapy in patients with triple negative breast cancer

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Background: Breast cancer (BC) is a common malignant tumor in female. In recent years, with the change of fertility pattern and lifestyle, the incidence of breast cancer is increasing year by year, seriously endangering the health and life of women. MRI is suitable for follow-up evaluation of the course of neoadjuvant chemotherapy in LABC, but there are few related studies and reports. Based on the above background, it is necessary to further evaluate the value of functional magnetic resonance imaging in neoadjuvant chemotherapy in patients with triple negative breast cancer, so as to lay a theoretical foundation for the popularization and application of this detection method. Based on this, this study was to explore the value, diagnostic efficacy and clinical importance of functional magnetic resonance imaging in evaluating the efficacy of neoadjuvant chemotherapy in patients with triple negative breast cancer.

Methods: A total of 62 patients with triple-negative breast cancer who received neoadjuvant chemotherapy in our hospital from September 2017 to September 2022 were selected. To compare the differences of functional magnetic resonance imaging (fMRI) between effective and ineffective patients with neoadjuvant chemotherapy, the related data were statistically analyzed.

Results: There was no significant difference between the mode of tumor withdrawal and the pathological complete remission of tumor tissue (P>0.05). There was no significant difference in anti-Trop-2 antibody-drug conjugates (ADC) data before and after chemotherapy between over-expressed patients with human epidermal growth factor receptor-2 (HER-2) and non-over-expressed patients with HER-2 (P>0.05). The levels of ADC and Δ ADC in pathological complete remission patients after chemotherapy were significantly higher than those in non-pathological complete remission patients (P<0.05). Using the ΔADC value as the evaluation parameter, the

pathological response of tumor tissue was classified as the "gold standard" to draw the ROC curve, the area under curve (AUC) was 0.673, the cut-off of ΔADC to evaluate the significant response of tumor tissue after chemotherapy was 1.418, the sensitivity of evaluating the efficacy was 71.9%, and the specificity was 55.0%.

Conclusion: Functional magnetic resonance imaging (fMRI) has diagnostic value for neoadjuvant chemotherapy in patients with triple negative breast cancer. According to the change of ADC value, the curative effect can be predicted early and the treatment strategy can be adjusted in time.

KEYWORDS

functional magnetic resonance imaging, triple negative breast cancer, neoadjuvant chemotherapy, diagnostic efficacy, clinical significance

1 Background

Breast cancer (BC) is a common malignant tumor in female. In recent years, with the change of fertility pattern and lifestyle, the incidence of breast cancer is increasing year by year, seriously endangering the health and life of women (1, 2). Triple negative breast cancer (TNBC) is a special type of breast cancer in which estrogen receptor, progesterone receptor and human epidermal growth factor receptor are negative. The incidence of triple-negative breast cancer accounts for 10%-17% of all types of breast cancer (3, 4). At present, the main treatment is chemotherapy. Neoadjuvant chemotherapy is a systemic and systemic cytotoxic drug treatment for patients with advanced breast cancer before surgery to downstage the primary tumor and lymph nodes, thereby achieving the purpose of breast-conserving surgery. The efficacy of neoadjuvant chemotherapy (NAC) is crucial to correctly guide the clinical selection of treatment options and maximize the benefits of NAC for patients. Preoperative neoadjuvant chemotherapy combined with surgery is currently considered an effective approach to improve the survival rate of patients with locally advanced BC (Locally Advanced Breast Cancer, LABC). COL11A1 is a potential therapeutic target in breast cancer and may be involved in the tumor immune infiltration; its high expression is strongly associated with poor prognosis (5, 6). The significance of neoadjuvant chemotherapy for BC is to enable locally advanced breast cancer patients to achieve surgery opportunities and breast-conserving patients with breast-conserving opportunities. The pathological classification of breast cancer can be divided into lobular carcinoma and ductal carcinoma, which occurs in the glandular epithelium of the lobar ducts of the breast and can spread along the duct. As a result, conventional imaging methods cannot accurately show the residual tumor after chemotherapy and the extent of the residual lesion, so the surgical plan cannot be accurately developed preoperatively (7).

The tumor volume reduction rate is an important factor for predicting the early postoperative prognosis of patients with no pathological complete remission after neoadjuvant chemotherapy, and magnetic resonance can most accurately evaluate the changes of focus volume before and after neoadjuvant chemotherapy. And the efficacy of neoadjuvant chemotherapy for BC was early evaluated and predicted by diffusion-weighted imaging and other functional imaging techniques (8, 9). The key of neoadjuvant chemotherapy for breast cancer is to improve the effective rate. With the continuous promotion and application of neoadjuvant chemotherapy in breast cancer patients, there is an urgent need for an examination method that can accurately evaluate tumor changes during chemotherapy. Early evaluation of the efficacy of neoadjuvant chemotherapy for BC before tumor morphological changes will directly affect the therapeutic effect and prognosis. Tumour variations in neoadjuvant chemotherapy for breast cancer can be followed by mammography, ultrasound and magnetic resonance imaging (MRI) (10). However, mammography is easily affected by tumor location and dense glands. Lesions that cannot be measured by previous X-ray can usually be followed up by ultrasound, but the accuracy of evaluation is easily limited by examination techniques (11, 12). Compared with the former two, MRI has high resolution on soft tissue, and enhanced scanning can more clearly display the tumor scope and internal details, and distinguish tumor tissue from breast glands and normal structures. Several parameters such as internal signal and dynamic enhancement features allow better differentiation of breast lesions, especially in showing specific sites of breast lesions, multifocal or multicentric breast cancer, pectoral muscle or chest wall invasion, and axillary lymph node metastases (13, 14). For a long time, during the course of follow-up, the therapeutic effect of tumor is often evaluated by the change of tumor size. However, in treatment, measurable morphological changes often occur later. We can consider using the biochemical metabolic changes of the tumor to use functional biological markers to measure and evaluate the early treatment response, in order to obtain better economic benefits (15). Some studies at home and abroad have reported that in terms of monitoring the therapeutic effect of tumor, the quantitative parameters of functional magnetic resonance imaging become an effective biological index to monitor the therapeutic effects on pre-change of tumor size (16, 17). By providing information on the blood supply and metabolism within the tumor, resonance functional imaging is expected to assess the efficacy of neoadjuvant chemotherapy at an early stage and assist in effective

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clinical management planning (18). Therefore, MRI is suitable for follow-up evaluation of the course of neoadjuvant chemotherapy in LABC, but there are few related studies and reports. Based on the above background, it is necessary to further evaluate the value of functional magnetic resonance imaging in neoadjuvant chemotherapy in patients with triple negative breast cancer, so as to lay a theoretical foundation for the popularization and application of this detection method. Based on this, 62 patients with triple-negative breast cancer who received neoadjuvant chemotherapy in our hospital from September 2017 to September 2022 were selected as the object of this study to explore the value, diagnostic efficacy and clinical significance of functional magnetic resonance imaging in evaluating the efficacy of neoadjuvant chemotherapy in patients with triple-negative breast cancer.

2 Materials and methods

2.1 General information

62 patients with triple negative breast cancer treated in our hospital from September 2017 to September 2022 were selected as the research object, all of whom were female. The age ranged from 29 to 63 years old, with an average of 46.54± 4.24 years. Body mass index (BMI) ranged from 17.77 to 28.15 kg/m^2, with an average of 24.04 ± 2.35 kg/m^2. The maximum diameter of the lesions was 3-7 cm, with an average of 4.12 ± 1.02 cm. The tumor stage included 25 cases of stage IIIa, 22 cases of stage IIIb, and 15 cases of stage IV. The education level showed 15 cases of primary school and junior high school, 20 cases of high school and technical secondary school, and junior college and above 27 cases. This study was approved by the Medical Ethics Council of our hospital, and all patients signed the informed consent form for the trial.

Inclusion criteria: 1) all the selected cases were diagnosed as triple negative breast cancer, and the diagnostic criteria were referred to the relevant literature (19); 2) the patients were ≥ 18 years old and had no cognitive, language and intellectual impairment, and had basic reading and writing ability; 3) breast invasive cancer was confirmed by hollow core needle biopsy; 4) neoadjuvant chemotherapy was confirmed.

Exclusion criteria: 1) patients with severe cardiac, liver and renal insufficiency; 2) patients who have received chemotherapy, endocrine therapy, regional radiotherapy or surgical resection; 3) patients with metal objects in their bodies (e.g. cardiac stents, internal fixation of fractures, pacemakers, etc.) cannot tolerate a full cycle of neoadjuvant chemotherapy and MRI;4) patients with severe mental disorders and cognitive impairment; 5) patients were participating in similar researchers.

2.2 Methods

Diffusion weighted imaging (MRDWI) was performed before neoadjuvant chemotherapy, and imaging evaluation was performed every two courses. All cases had complete clinical and imaging data, completed all courses of neoadjuvant chemotherapy, obtained patients' informed consent, agreed and willing to accept the whole course of treatment and follow-up on time.

Instrument and scanning method: using GE SignaExciteHD3.0T ultra-high field magnetic resonance scanner, using breast special coil, the patient adopted prone position, foot advanced, bilateral breast natural prolapse. The scanning range included double breast and axillary area, patients kept natural breathing during scanning. Scanning sequence and parameters were as follows: T1WI axial position, TR500ms, TE8.5ms, slice thickness 6mm, scanning time 175s. Axis T2WI reversed recovery fat inhibition sequence (STIR), TR4000ms, TE56ms, thickness 6mm, scanning time 3min; Axis SE/EPIDWI, diffusion sensitivity coefficient b was 1000s/mm2, TR5000ms, TR5000ms, and TE was the minimum echo time, with a thickness of 3mm, an interval of 1mm, and a scanning time of 105s.

Image analysis: the DWI raw data were transferred to ADW4.4 workstation, and the Functool2.0 software was used for image post-processing to get the apparent diffusion coefficient (ADC) map. The double-blind method was used to analyze and evaluate the lesions before and after neoadjuvant chemotherapy by two experienced deputy chief physicians.

Specific methods: the largest cross-section of the lesion was found manually, and a circular area of interest was placed where the lesion signal was homogeneous for ADC measurements. Each ROI area should be no less than 3 Pixel to avoid necrotic areas, peripheral edema and vascular volume effects. Three ROI were placed in each lesion area for measurement, and the lower one was taken as the criterion.

Pathological examination and evaluation of the efficacy of chemotherapy: according to the Miller Payne pathological response classification standard, it was divided into 5 grades. Grade 1 for tumor cells without retraction; Grade 2 for tumor cell retraction less than 30%; Grade 3 for tumor cell retreat about 30%; Grade 4 for tumor cell retraction more than 90%; Grade 5 for tumor complete disappearance or carcinoma in situ.

2.3 Observation index

The age, menstrual status, lymph node metastasis, TNM stage, chemotherapy regimen, vascular tumor thrombus and nerve invasion were analyzed. The relationship between the mode of tumor withdrawal and the complete remission of tumor pathology was analyzed. The ADC values of different types of BC before and after chemotherapy were calculated. The relationship between the efficacy of adjuvant chemotherapy and ADC was analyzed. Δ ADC was used as a parameter for ROC curve analysis.

2.4 Statistical analysis

Using SPSS21.0 statistical software, measurement data were tested for normal distribution and homogeneity of variance before statistical analysis. Measurement data that met the requirements of normal distribution or approximately normal distribution were expressed as ($\bar{x} \pm s$), and comparisons between groups were carried out. The t test was used, and the paired t test

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was used for comparison within groups. Taking n (%) as an example to represent the counting data, χ 2 test was adopted, and the receiver working curve (ROC) with Δ ADC as a parameter was analyzed. $P<0.05$ indicated that the differences were statistically significant.

3 Results

3.1 Clinical data of patients

The data of age, menstrual status, lymph node metastasis, TNM stage, chemotherapy regimen, vascular tumor thrombus and nerve invasion are shown in Table 1.

3.2 Relationship between tumor withdrawal mode and tumor histopathological complete remission

There was no significant difference between tumor withdrawal mode and pathological complete remission of tumor tissue ($P>0.05$). All the data were shown in Table 2.

3.3 Differences of ADC value between different types of breast cancer before and after chemotherapy

There was no significant difference in ADC data between HER-2 overexpressed patients and HER-2 non-overexpressed patients before and after chemotherapy ($P>0.05$). All data results are shown in Table 3.

3.4 The relationship between the efficacy of adjuvant chemotherapy and ADC

The levels of ADC and Δ ADC in pathological complete remission patients after chemotherapy were significantly higher than those in non-pathological complete remission patients ($P<0.05$). All the data results are shown in Table 4 and Figure 1.

3.5 Analysis of ROC curve with Δ ADC as a parameter

The tumor ADC value was used as the evaluation parameter, the tumor tissue pathological reaction was classified as the "gold standard" as the ROC curve, the AUC was 0.673, the cut-off of Δ

TABLE 1 Clinical data of patients [n/%].

Group	classification	
Age	≤35	9(14.51%)
	36-60	42(67.74%)
	≥61	11(17.74%)
Menstrual state	Menopause	21(33.87%)
	Premenopausal	41(66.12%)
Number of lymph node metastasis	0	15(24.19%)
	1-3	17(27.41%)
	≥4	30(48.38%)
TNM Staging	I	3(4.83%)
	II	25(40.32%)
	III	34(54.83%)
Chemotherapy regimen	AC(EC)-T	15(24.19%)
	TA(E)	41(66.12%)
	TEC	2(3.22%)
	Other options	4(6.45%)
Is it complicated with vascular tumor thrombus?	Yes	16(25.80%)
	None	45(72.58%)
	Uncertain	1(1.61%)
Whether it is complicated with nerve invasion	Yes	9(14.51%)
	None	52(83.87%)
	Uncertain	1(1.61%)

TABLE 2 The relationship between tumor withdrawal mode and tumor histopathological complete remission [n/%].

Group	Pathological complete remission	Non-pathological complete remission	χ^2	*P*
N	24	38		
Fragmentary form	9/37.5	18/29.03	1.305	0.52
Centripetal nature	12/50.0	18/29.03		
Unknown	3/4.83	2/3.22		

ADC to evaluate the significant response of tumor tissue after chemotherapy was 1.418, the sensitivity was 71.9%, and the specificity was 55.0%. All the data results are shown in Figure 2.

4 Discussion

As one of the standard treatments for locally advanced BC, neoadjuvant chemotherapy has been supported by more and more clinical workers. As a criterion for evaluating the efficacy of neoadjuvant chemotherapy, pathological diagnosis can be observed in terms of tumor sensitivity to chemotherapeutic agents. Studies support that patients in complete remission (PCR) have a higher survival rate (20–29), making PCR a target for neoadjuvant chemotherapy. This study has attempted to screen the factors affecting PCR from the clinicopathological data of patients, so as to give hints to clinical practice. As the pathological results can only be obtained after the end of neoadjuvant chemotherapy, the evaluation method used in the process of chemotherapy has become a matter of concern (30). At present, magnetic resonance imaging (MR) is internationally recognized as the most accurate method to evaluate the efficacy of NAC before operation. The growth of BC depends on the nourishment of tumor blood vessels. After NAC treatment, the blood supply to the necrotic and degenerative areas of the mass is significantly reduced. In contrast, the MR contrast agent can cross the vessel wall to reach local equilibrium within the tissue space. The markedly enhanced areas in DCE-MR can be increasingly accepted as a novel diagnostic method due to its non-invasiveness, objectivity and high sensitivity (31). It has become one of the standard ways to evaluate the efficacy of neoadjuvant chemotherapy (32). MRI functional imaging and contrast-enhanced imaging can explain the effect of chemotherapy from a microscopic point of view, which can reveal the effect of chemotherapy early, thus giving clinical workers a hint of whether to continue the original chemotherapy regimen or change other chemotherapy regimens or timely surgical treatment (33). Accurate and reliable evaluation plays an important role in chemotherapy management to avoid unnecessary chemotherapy and minimize the occurrence of chemotherapy-related adverse events (34, 35).

In this study, 62 patients with triple negative breast cancer who received neoadjuvant chemotherapy in our hospital from September 2017 to September 2022 were selected. The results of the study showed that there was no significant difference between the way of tumor regression and the pathological complete remission of the tumor tissue, indicating that the pathological complete remission of the tumor tissue of the patient had weak correlation with the tumor regression type. There was no significant difference in ADC data between HER-2 overexpressing patients and HER-2 non-overexpressing patients before and after chemotherapy, indicating that there was no significant difference in ADC data between the two groups. The ADC and ΔADC levels after chemotherapy in patients with pathological complete remission were significantly higher than those in patients without pathological complete remission. Using the ΔADC value as the evaluation parameter, the pathological response of tumor tissue was classified as the "gold standard" to make the ROC curve, the AUC was 0.654, and the cut-off value of ΔADC to evaluate the significant response of tumor tissue after chemotherapy was 1.272×10-3mm2/s. The sensitivity of efficacy was 61.5%, and the specificity was 75.0%. According to the data of the study, there are significant differences in ADC levels among patients receiving neoadjuvant therapy with different remission outcomes, suggesting that functional magnetic resonance imaging is expected to indicate the outcome of neoadjuvant chemotherapy. As a treatment predictor, ROC curve analysis yields significant critical values with high sensitivity and specificity, and is expected to be used to determine the effect of neoadjuvant chemotherapy in advance. This examination method is worth popularizing and applying in clinic. In this study, multicenter and large sample study is needed for the application of ADC in clinical diagnosis due to the limited sample size. Diffusion-weighted magnetic resonance imaging is a non-invasive imaging method, which can reflect the Brownian motion of water molecules in biological tissues. The apparent diffusion coefficient value is a parameter of diffusion weighted

TABLE 3 Differences of ADC value between different types of breast cancer before and after chemotherapy [$\bar{x}\pm s$].

Pathological features	HER-2 overexpression	HER-2 is not overexpressed	*t*	*P*
N	33	29		
Before chemotherapy	0.936 ± 0.135	1.013 ± 0.361	1.139	0.259
After chemotherapy	1.385 ± 0.363	1.234 ± 0.417	1.524	0.132
t	6.61	2.236		
P	<0.01	0.029		

TABLE 4 The relationship between efficacy of adjuvant chemotherapy and ADC [$\bar{x}\pm s$].

Group	Pathological complete remission	Non-pathological complete remission	*t*	*P*
N	24	38		
Before operation ADC	0.983 ± 0.156	1.002 ± 0.132	0.514	0.608
After operation ADC	1.473 ± 0.314	1.183 ± 0.231	4.182	<0.01
ΔADC	0.374 ± 0.157	0.162 ± 0.217	4.144	<0.01

imaging (DWI), which can quantify the fluidity of water molecules and reflect information about cell membrane integrity and tumor cells (36). Among the many MR evaluation indexes, tumor volume, maximum tumor diameter and outflow curve are considered to be most related to pathological evaluation system (37). Because most tumors have irregular boundaries and do not have the assistance of CAD software, this study is based on tumor maximum diameter, time-signal intensity curve (TIC), diffusion weighted imaging-apparent diffusion coefficient. The variation in DWI-ADC was evaluated to determine the effectiveness of NAC, and then the maximum diameter of the tumor was used as an indicator of accuracy. In one patient with triple-negative breast cancer, the maximum tumour diameter increased by more than 20% after chemotherapy. The criteria for evaluating the efficacy of solid tumors (RECIST) should be classified as lesion progression (38), but the ADC value increased significantly after treatment (from 0.784 to 1.221). The TIC curve changed from type III to type II before and after chemotherapy. The reason for the increase of the maximum diameter of the tumor may be related to the increased responsiveness caused by tumor necrosis after NAC treatment. After comprehensive evaluation, it is considered that NAC is effective. Thus, it can be seen that the judgment of the effectiveness of NAC treatment needs to be combined with a comprehensive analysis of multiple parameters (39). Therefore, timely and accurate evaluation of the efficacy of breast cancer NAC, clear residual tumor size, boundary, timely adjustment of treatment plan is of great significance to improve the prognosis of patients (40). It has become a research hotspot to evaluate the response of breast tumors to NAC through the changes of ADC values measured by it. Ehsani An et al. found that TNBC has a higher ADC value and the highest PCR rate after NAC (41). Allard-CoutuA et al. compared the ADC value and tumor size before NAC treatment with that after the first NAC cycle (42). The results showed that the ADC value increased significantly after the first NAC cycle, but no significant change in tumor size was found. In addition, a study by Siow Z.R et al. reported that a combined model combining ADC values measured by DWI and functional tumor volume parameters measured by DCE-MRI could improve the prediction performance of tumor NAC response, making the AUC of TNBC after NAC improved (43). These studies suggest that the ADC measured by DWI can be used as an early predictor of chemotherapy response compared to tumor size. In addition, the combined model of DWI and DCE-MRI shows better prediction efficiency (44). However, there are few reports on the evaluation and prediction of the efficacy of TNBC tumor subtype NAC based on DWI. The large sample and multicenter studies are still needed in the future to verify its application value in TNBC. Magnetic resonance diffusion-weighted imaging can be used to detect the diffusion of water molecules in the body by ADC value, so as to observe and analyze the tissue structure and internal characteristics. Therefore, DWI can evaluate the early response of tumor cells to NAC by detecting the changes of tumor microenvironment before and after chemotherapy. Previous studies have shown that the ADC value is negatively correlated with the cell density in the tissue (45). When the cell density in the tissue is high, the movement disorder of water molecules is greater, the ADC value is lower. On the contrary, when the cell density is low, the movement disorder of water molecules will

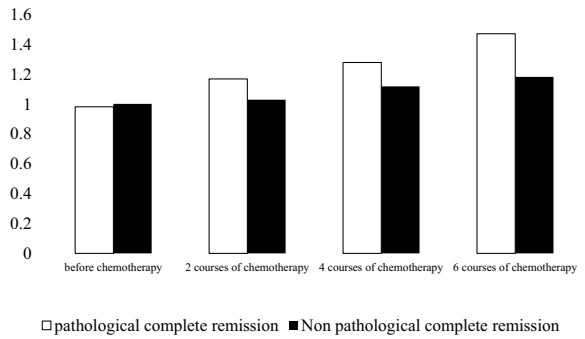

FIGURE 1
The relationship between the efficacy of adjuvant chemotherapy and ADC.

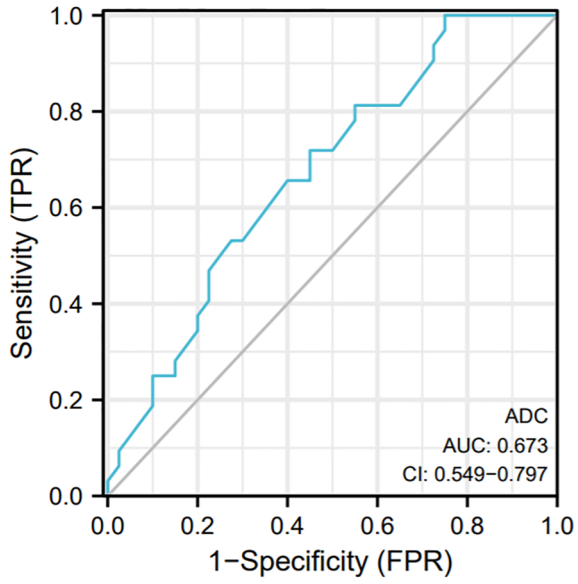

FIGURE 2
ROC curve analysis with Δ ADC as a parameter.

decrease and the ADC value increases. If the treatment is effective, cell density decreases after tumor cell necrosis, water molecular motility disorders decrease and ADC values increase. DWI is time consuming and does not require contrast injection. ADC values to detect the early efficacy of neoadjuvant chemotherapy is a quick, effective and easy method. However, DWI does not show small lesions well because of its poor spatial resolution and the quality of the anatomical images is far from that of enhanced scans. Among the breast imaging examinations for pre-menopausal patients, breast MR is very important, mainly to compensate for the lack of mammograms and ultrasounds, to prevent false-negative lesions with the residual of other examinations, and is an irreplaceable imaging examination in breast-conserving surgery. Pathological examination is the gold standard for objective evaluation of the efficacy of treatment. However, it is an invasive test and puncture pathology is limited by sampling and does not allow for a comprehensive evaluation of the response of the neoplasm to drugs. At present, grading system is mainly used to evaluate breast cancer at home and abroad. According to the changes of tumor volume before and after chemotherapy, it is divided into effective group and ineffective group. Comparing the average ADC value of breast cancer before and after chemotherapy, it is considered that the ADC value of effective group before chemotherapy is lower than that of ineffective group. According to the ADC value of tumor before chemotherapy, the curative effect of breast cancer NAC can be predicted. No matter what kind of clinical evaluation criteria are used, the tumor size is used as an index. At present, the size of the tumor should be judged by clinical palpation and imaging examination. MRI has the advantages of good tissue contrast, multi-parametric imaging and no ionising radiation, and therefore has clear advantages and potential for monitoring the efficacy of chemotherapy in breast cancer. A comparative study of MRI findings and histological response after NAC showed that there was no significant correlation between the size of the residual tumor and the pathological response. It is feasible to evaluate the curative effect of breast cancer based on changes in NAC values, and the pathological changes in the tumor after chemotherapy underlie the increase in ADC values. In this study, it was found that there was a significant difference in the average ADC value of breast cancer which was effective to NAC before and after treatment, while there was no significant change in ADC value before and after treatment for tumors that were ineffective to chemotherapy. The differences could be observed at the end of two courses of chemotherapy. Therefore, it can be considered that there is a correlation between the change of ADC value and the efficacy of chemotherapy. The increase of ADC value is an effective manifestation of chemotherapy. Observation of changes in ADC values can provide a basis for early determination of the efficacy of chemotherapy for oncology. The change of ADC value of tumor is earlier than the change of tumor volume and diameter. The ADC value of tumor sensitive to NAC can increase at the end of one course of chemotherapy, which is similar to the results of this study. DWI can be used to evaluate the efficacy of NAC in early breast cancer. According to the change of ADC value, the curative effect can be predicted early and the treatment strategy can be adjusted in time. Magnetic resonance diffusion-weighted imaging is used to observe and analyze the tissue structure and internal characteristics by detecting the dispersion of water molecules in the tissue. Usually on the DWI map, the malignant tumor of the breast is significantly different from the gland and the surrounding fat, which can accurately distinguish the boundary of the focus. Most of the malignant breast lesions showed obvious high signal intensity on DWI. Compared with the ADC value of diffusion weighted imaging, the ADC value of malignant tumor was significantly lower than that of Liangsheng tumor and surrounding breast tissue. Therefore, DWI can monitor breast cancer, and can evaluate and predict the efficacy of neoadjuvant chemotherapy for breast cancer by defining the range of breast cancer foci and accurately evaluating the changes of tumor size. Because of the high signal intensity of necrotic areas in the tumor on diffusion-weighted images, DWI also has the value of detecting necrotic changes in breast cancer after intratumorally treatment. DWI can evaluate the early response of tumor cells to NAC by detecting the changes of tumor microenvironment. Moreover, it has been found that diffusion weighted imaging can evaluate the therapeutic response of breast cancer model in NAC, not only by DWI map, but also by the change of apparent diffusion coefficient (ADC). Many studies have confirmed that Dwl can be used to monitor the variations of tissue and intracellular structure binding water before the change of tumor size in the early stage of tumor treatment. In the early stages of treatment, the tumor signal intensity on diffusion-weighted maps decreased significantly and the apparent diffusion coefficient increased significantly, while the tumour volume measured on DWI maps did not recede significantly. DWI has the advantages of no enhancement and short examination time, so the detection of ADC value of breast tumor is a fast and easy method to evaluate the curative effect. But the spatial resolution of DWI is relatively poor and the quality of anatomical image is much lower than that of enhanced scan, it is difficult to show small lesions. Therefore, there are not many clinical applications in the diagnosis of breast diseases, and its technical improvement and its significance are still under further discussion.

5 Conclusion

To sum up, functional magnetic resonance imaging has diagnostic value for neoadjuvant chemotherapy in patients with triple negative breast cancer. According to the changes of ADC value, the curative effect can be predicted early and the treatment strategy can be adjusted in time.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The animal study was reviewed and approved the Ethics Committee of Lianyungang First People's Hospital. The patients

have given their consent for publication. Written informed consent was obtained from the patients for publication of this report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal.

Author contributions

XH were major contributors in writing the manuscript. ZW collected the patient data. YZ performed both surgeries and followed up the patients. YF realized the scarcity of the two cases, did literature searches, and revised the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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