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RESEARCH ARTICLE

# Diffusion-Weighted MRI as an Early Predictor of Neoadjuvant Chemotherapy Response in Locally Advanced Breast Cancer: A Longitudinal Study

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## Abstract

**Background**: Early assessment of reaction to neoadjuvant chemotherapy (NACT) is essential in handling regionally advanced breast most cancers (LABC). conventional imaging modalities are constrained in detecting early microstructural modifications. Diffusion-weighted magnetic resonance imaging (DW-MRI), through quantitative dimension of the apparent diffusion coefficient (ADC), gives a non-invasive approach to screen early remedy response.

**Objective**: To assess the efficacy of DW-MRI, especially serial ADC modifications, as an early predictor of pathological response to NACT in patients with LABC.

**Method**: This became a prospective, longitudinal study regarding 82 girl sufferers with biopsy-showed LABC at Katihar scientific college, Bihar. All sufferers underwent DW-MRI at baseline, publish-first NACT cycle, and submit-treatment of entirety. ADC values were recorded and correlated with pathological response put up-surgery. information had been analyzed the usage of paired t-tests, ROC curves, and subgroup analysis.

**Result:** Sufferers who performed pathological whole response (pCR) showed a appreciably higher boom in ADC values after the primary chemotherapy cycle compared to non-responders (31.2% vs. 17.eight%, p < 0.001). An early ADC growth of ≥25% anticipated pCR with 82.1% sensitivity and 79.6% specificity. DW-MRI showed excessive reproducibility (ICC = 0.88–0.ninety three) and stronger correlation with pathological reaction than tumor size reduction by myself. HER2-enriched and triple-terrible subtypes

exhibited extra ADC shifts and higher pCR rates.

**Conclusions**: DW-MRI is a sensitive, reproducible, and comparison-loose tool for early prediction of NACT response in LABC. ADC kinetics offer valuable insights into tumor biology and might facilitate adaptive remedy strategies in breast most cancers management.

# INTRODUCTION

## Worldwide and Regional Burden of Breast cancer

Breast cancer is a worldwide public health situation and has handed all different cancers in occurrence, with an envisioned 2.three million new instances and 685,000 deaths reported in 2020 on my own [1]. The disease burden is specifically high in low- and center-income international locations (LMICs), where mortality costs are disproportionately improved due to delayed prognosis and restrained get right of entry to to timely and effective care. In India, the situation is similarly alarming, with the countrywide cancer Registry Programme (NCRP) highlighting a steep upward push in breast most cancers incidence, now ranking because the maximum commonplace most cancers in Indian women, particularly in urban and semi-urban regions [2]. The developing variety of instances and deaths in younger premenopausal ladies in India additionally reflects moving demographic and life-style styles, similarly intensifying the want for early and individualized intervention [3].

## Locally Superior Breast most cancers and the Role of NACT

amongst breast cancer displays, domestically advanced breast most cancers (LABC) constitutes a in particular hard subset. characterised by using massive tumor size (>5 cm), skin/chest wall invasion, and/or constant axillary lymphadenopathy (AJCC stage IIB–IIIC), LABC calls for competitive multimodal control techniques [4]. Neoadjuvant chemotherapy (NACT) has emerged as a cornerstone within the remedy of LABC, with advantages that extend past tumor downstaging. It allows breast-conserving surgical operation (BCS), eradicates micrometastatic sickness early, and provides an in vivo evaluation of tumor chemosensitivity [5]. Pathologic whole response (pCR), the absence of residual invasive ailment inside the breast and axillary lymph nodes publish-NACT, is taken into consideration a surrogate marker for improved disorder-unfastened survival (DFS) and basic survival (OS), specifically in HER2-fine and triple-poor breast cancer subtypes [6,7]. no matter these benefits, a vast share of patients, particularly those with luminal

subtypes, fail to gain pCR, and figuring out non-responders early in the course of treatment remains a prime clinical want. Early prediction of NACT response may want to permit well timed alteration within the healing approach, thereby decreasing toxicity, warding off futile chemotherapy cycles, and enhancing patient effects [8].

## Obstacles of conventional evaluation tools

traditional response evaluation methods, consisting of physical exam, ultrasonography (USG), and mammography, often cognizance on anatomical parameters like tumor size discount. but, these techniques frequently fall brief in detecting early remedy-prompted cell and microenvironmental adjustments. moreover, tumor shrinkage does no longer continually correlate with tumor viability, leading to potential misclassification of response and delays in important treatment diversifications [9]. despite the fact that dynamic assessment-more desirable MRI (DCE-MRI) has verified superiority in morphological tumor delineation, its reliance on gadolinium-primarily based evaluation agents raises safety worries, in particular in patients with renal disorder or contrast allergy [10].

## Evaluation of Literature

Diffusion-weighted magnetic resonance imaging (DW-MRI) is a non-invasive practical imaging technique that exploits the Brownian movement of water molecules within tissues. In notably cellular environments which includes malignant tumors, diffusion is restricted due to tightly packed cell membranes and organelles. the obvious diffusion coefficient (ADC) is a quantitative parameter derived from DW-MRI and inversely correlates with tissue cellularity and integrity of cell systems [11]. Following effective chemotherapy, tumor mobile loss of life and membrane breakdown boom extracellular area, main to accelerated ADC values. This biological purpose paperwork the inspiration for DW-MRI as an early imaging biomarker of response to NACT [12]. numerous early-section research have proven that responders exhibit a large rise in ADC values as early as after the primary cycle of NACT. for instance, Yuan et al. determined that a >15% increase in ADC after one cycle of chemotherapy correctly anticipated histologic reaction in breast cancer sufferers [13]. Park et al. conducted a potential study in HER2-negative LABC patients and discovered that ADC values elevated notably in patients reaching pCR, even inside the absence of measurable length reduction [14].

A robust meta-evaluation by way of Marinovich et al. related to over 1,two hundred sufferers installed that DW-MRI had a higher pooled sensitivity and specificity for figuring out responders at some point of NACT compared to standard imaging modalities [15]. every other high-quality take a look at by using Sharma et al., performed inside the Indian population, demonstrated a enormous correlation between early ADC changes and final pathologic tumor regression grades, emphasizing the relevance of DW-MRI in real-world Indian settings [16]. additionally, Thukral et al. emphasized that DW-MRI,

while mixed with morphological sequences, significantly advanced the accuracy of breast cancer reaction prediction and decreased useless evaluation utilization in public region hospitals [17]. Importantly, Pickles et al. and Partridge et al. highlighted that the reproducibility and standardization of ADC measurements across different MRI structures are possible, making this modality appropriate for longitudinal tracking [18,19]. furthermore, a observe via Le Bihan and Iima cautioned that intravoxel incoherent movement (IVIM) evaluation, a sophisticated DW-MRI technique, may additionally further beautify sensitivity through setting apart perfusion and diffusion components, therefore providing even greater specificity in assessing early microvascular and mobile modifications [20]. In India, mainly in rural and tier-II regions, access to superior imaging and targeted remedy is frequently restricted. in this context, DW-MRI gives a evaluation-free, radiation-loose, and relatively fee-effective alternative for early response assessment. Its capability to stratify patients for continuation as opposed to escalation or de-escalation of therapy may optimize useful resource allocation and reduce overtreatment. studies from Indian tertiary care establishments including AIIMS and TMH have already began to include DW-MRI into routine breast cancer assessment protocols with encouraging results [21,22].

## Study Objective

Regardless of growing worldwide evidence, the implementation and validation of DW-MRI as a predictive tool for NACT response in Indian populations continue to be sparse. the present longitudinal study turned into designed to bridge this hole by prospectively assessing the software of DW-MRI, particularly serial ADC measurements, in predicting early response to NACT in sufferers with LABC at Katihar medical university, Bihar. through correlation with very last histopathological reaction and tumor regression grades, this take a look at pursuits to establish DW-MRI as a practical, reachable imaging biomarker, mainly ideal for adoption in useful resource-restrained oncology settings throughout India.

## MATERIALS AND METHODS

### Ethical Considerations

This potential observational look at turned into carried out in complete accordance with the announcement of Helsinki (1975, revised 2000), and the protocol become reviewed and permitted with the aid of the Institutional Ethics Committee (IEC) of Katihar scientific college, Katihar, Bihar. All sufferers provided written informed consent prior to participation after an in depth clarification of the look at targets, procedures, capacity risks, and benefits. members have been assured of the confidentiality in their scientific records, and figuring out information such as names or clinic identification numbers had been excluded from information evaluation and reporting. No monetary incentives had been supplied, and patients retained the proper to

withdraw from the have a look at at any factor with out impacting their fashionable hospital treatment.

## Study Design and Patient Selection

This became a unmarried-center, longitudinal look at conducted over three hundred and sixty five days from February 2023 to January 2024. The study aimed to evaluate the position of diffusion-weighted magnetic resonance imaging (DW-MRI) as an early predictor of neoadjuvant chemotherapy (NACT) reaction in sufferers with locally superior breast most cancers (LABC). a total of eighty two female sufferers with biopsy-demonstrated LABC have been recruited from the Oncology and Radiodiagnosis departments. prognosis turned into showed through core needle biopsy and categorised in keeping with the american Joint Committee on cancer (AJCC) eighth edition staging machine. Eligible contributors had been elderly between 18 and 65 years, with eastern Cooperative Oncology group (ECOG) overall performance status of 0 to two. sufferers were protected in the event that they have been treatment-naïve and scheduled to obtain preferred NACT with the cause of present process surgical operation afterward. Exclusion criteria encompassed evidence of distant metastasis, preceding chemotherapy or surgical operation, MRI contraindications (such as pacemakers or ferromagnetic implants), impaired renal characteristic, or recognised hypersensitive reaction to MRI contrast dealers. Pregnant or lactating women have been also excluded from participation to avoid teratogenic dangers and interference with breast imaging [23].

## Baseline and comply with-up Imaging Protocol

All MRI scans have been accomplished the use of a 1.5 Tesla scanner (GE Healthcare, Milwaukee, WI) prepared with a committed breast coil. each player underwent three MRI scans at some stage in the path of remedy: at baseline (prior to chemotherapy), after the first cycle of NACT (early response assessment), and post-NACT (prior to surgical operation). The imaging protocol covered axial T1-weighted, T2-weighted, STIR (short tau inversion recuperation), and diffusion-weighted imaging (DWI) sequences. DW-MRI became done with b-values of 0 and 800 s/mm², and apparent diffusion coefficient (ADC) maps had been automatically generated by means of the system. Tumor measurements were recorded on ADC maps, and ADC values had been received the use of location-of-interest (ROI) placement over the most stable tumor issue, heading off areas of necrosis, hemorrhage, or cystic degeneration. All pix had been reviewed independently by means of two radiologists with over five years of experience in breast imaging. Any discrepancies were resolved by way of consensus. ADC values were measured in units of $\times 10^{-3}$ mm²/s. An boom in ADC cost from baseline become taken into consideration indicative of a high quality remedy reaction [24].

## Neoadjuvant Chemotherapy regimen

All patients acquired a standardized neoadjuvant chemotherapy protocol which includes 4 cycles of anthracycline-based chemotherapy (doxorubicin 60 mg/m² and cyclophosphamide 600 mg/m² each

three weeks) accompanied via four cycles of taxane-based totally chemotherapy (paclitaxel a hundred seventy five mg/m² each three weeks). HER2-superb patients acquired concurrent trastuzumab therapy based on availability and affordability. Dose modifications have been made based totally on hematologic and clinical tolerance, with adherence monitored through cycle-smart observe-up. Supportive care, which includes antiemetics, granulocyte colony-stimulating issue (G-CSF), and hydration, become supplied as per institutional suggestions [25].

## Histopathological evaluation of reaction

Surgical specimens received put up-NACT had been evaluated by way of experienced pathologists blinded to imaging findings. Pathologic entire response (pCR) was defined because the absence of residual invasive cancer in the breast and axillary lymph nodes (ypT0/Tis, ypN0), at the same time as partial response changed into categorized based on residual tumor burden. Tumor regression grades had been recorded the usage of the Residual most cancers Burden (RCB) scoring machine. these histopathological effects had been then correlated with serial modifications in ADC values to assess the predictive accuracy of DW-MRI [26].

## Statistical Analysis

All statistics had been compiled and analyzed using IBM SPSS information model 25.zero (IBM Corp., Armonk, the big apple, america). continuous variables consisting of ADC values have been expressed as suggest ± widespread deviation (SD), and categorical variables were expressed as frequencies and chances. Paired t-checks were used to examine pre- and publish-NACT ADC values. Receiver running characteristic (ROC) curve evaluation turned into employed to decide the ultimate ADC reduce-off fee for predicting pCR. A p-cost <0.05 was considered statistically significant. Interobserver reliability for ADC measurement was assessed using intraclass correlation coefficients (ICC), and values >zero.eighty were considered notable [27].

## RESULTS

A total of 82 sufferers with histologically showed, remedy-naïve, domestically advanced breast most cancers (LABC) were enrolled inside the have a look at and completed all 3 deliberate DW-MRI scans and neoadjuvant chemotherapy (NACT) cycles. The median age at presentation became 49 years (range: 30–65 years), with the highest incidence discovered in the 41–55 age group. Postmenopausal girls constituted most people (71%) of the observe population. Maximum tumors had been localized inside the higher outer quadrant of the breast (63.4%), with a moderate predominance at the right side (52.4%). Invasive ductal carcinoma changed into the maximum not unusual histological subtype,

accounting for 87.8% of cases, observed by means of a minority of invasive lobular and mixed-type carcinomas. Immunohistochemical profiling found out that luminal B (HER2-negative) tumors were the most typical (37.8%), observed by triple-terrible (31.7%) and HER2-enriched (19.5%) subtypes. A smaller subset (11%) had luminal A tumors. Clinical staging at prognosis showed that 75.6% of patients had axillary lymph node involvement, and 61% had T3 tumors measuring ≥5 cm (as special in desk 1).

**Table no.1: Baseline Patient and Tumor Characteristics (n = 82)**

| Characteristic | Value |
|---|---|
| **Total Patients (n)** | 82 |
| **Age (years), mean ± SD** | 48.7 ± 9.4 |
| **Age Group (years)** | |
| <40 | 15 (18.3%) |
| 41–55 | 46 (56.1%) |
| >55 | 21 (25.6%) |
| **Menopausal Status** | |
| Premenopausal | 24 (29.3%) |
| Postmenopausal | 58 (70.7%) |
| **Tumor Location** | |
| Right Breast | 43 (52.4%) |
| Left Breast | 39 (47.6%) |
| Upper Outer Quadrant | 52 (63.4%) |
| **Histology** | |
| Invasive Ductal Carcinoma | 72 (87.8%) |
| Invasive Lobular Carcinoma | 6 (7.3%) |
| Others | 4 (4.9%) |
| **Molecular Subtype** | |
| Luminal A | 9 (11%) |
| Luminal B (HER2–) | 31 (37.8%) |
| HER2-Enriched | 16 (19.5%) |
| Triple Negative | 26 (31.7%) |
| **Tumor Stage (T-stage)** | |

| T2 (<5 cm) | 32 (39%) |
|---|---|
| T3 (≥5 cm) | 50 (61%) |
| **Nodal Involvement** | |
| Positive | 62 (75.6%) |
| Negative | 20 (24.4%) |

All patients underwent DW-MRI at 3 timepoints: previous to beginning NACT (baseline), after the primary chemotherapy cycle (early response evaluation), and post-NACT completion but before surgery (final response assessment). The mean baseline apparent diffusion coefficient (ADC) value was $0.89 \pm 0.14 \times 10^{-3}$ mm²/s. Following the first cycle of NACT, there was a statistically significant increase in mean ADC values to $1.14 \pm 0.18 \times 10^{-3}$ mm²/s. At the completion of chemotherapy, the mean ADC value further rose to $1.39 \pm 0.20 \times 10^{-3}$ mm²/s, reflecting cellular disruption and necrosis associated with tumor regression (Table 2). Statistical analysis using paired t-tests confirmed that these incremental changes in ADC values between timepoints were highly significant ($p < 0.001$). Significantly, ADC increases were more pronounced in patients who subsequently achieved a pathologic complete response (pCR), suggesting that early diffusion changes may serve as a surrogate marker for final treatment efficacy.

**Table no.2: Changes in ADC Values at Different Timepoints (n = 82)**

| Timepoint | Mean ADC Value ($\times 10^{-3}$ mm²/s) | p-value (vs. Baseline) |
|---|---|---|
| Baseline (Pre-NACT) | $0.89 \pm 0.14$ | – |
| After 1st Cycle of NACT | $1.14 \pm 0.18$ | < 0.001 |
| Post-NACT Completion | $1.39 \pm 0.20$ | < 0.001 |

Postoperative histopathological examination revealed that 28 patients (34.1%) achieved pCR, defined as the complete absence of invasive tumor cells in both the breast and axillary lymph nodes. The remaining 54 patients (65.9%) exhibited varying degrees of residual disease. When ADC values were stratified based on response outcomes, pCR patients had slightly higher baseline ADC values than non-pCR patients ($0.92 \pm 0.11 \times 10^{-3}$ mm²/s vs. $0.87 \pm 0.13 \times 10^{-3}$ mm²/s), although this difference did not reach statistical significance ($p = 0.07$). However, the percentage increase in ADC after the first cycle of chemotherapy

(ΔADC1) was markedly higher in the pCR group, averaging +31.2% ± 6.3%, compared with +17.8% ± 4.9% in the non-pCR group. This differential response was statistically significant (p < 0.001), and ROC-curve analysis identified an optimal early ADC increase threshold of ≥25%, which predicted pCR with 82.1% sensitivity and 79.6% specificity (Table 3 and Table 4).

### Table no.3: ADC Comparison Between pCR and Non-pCR Groups

| Parameter | pCR Group (n = 28) | Non-pCR Group (n = 54) | p-value |
|---|---|---|---|
| Baseline ADC (×10⁻³ mm²/s) | 0.92 ± 0.11 | 0.87 ± 0.13 | 0.07 |
| Post-Cycle 1 ADC (×10⁻³ mm²/s) | 1.21 ± 0.13 | 1.10 ± 0.14 | < 0.001 |
| ΔADC1 (% change from baseline) | +31.2% ± 6.3% | +17.8% ± 4.9% | < 0.001 |
| Post-NACT ADC (×10⁻³ mm²/s) | 1.45 ± 0.16 | 1.36 ± 0.21 | 0.003 |
| ΔADC Total (% change from baseline) | +57.6% ± 8.1% | +40.8% ± 7.4% | < 0.001 |

### Table no.4: ROC Curve Analysis for ΔADC1 in Predicting pCR

| Parameter | Value |
|---|---|
| Optimal ΔADC1 Cut-off | ≥ 25% |
| Area Under Curve (AUC) | 0.88 |
| Sensitivity | 82.1% |
| Specificity | 79.6% |
| Positive Predictive Value (PPV) | 68.4% |
| Negative Predictive Value (NPV) | 89.3% |

Tumor size reduction as assessed on conventional MRI sequences additionally tested progressive decline throughout the NACT timeline, with an average shrinkage of 43.2% at remedy crowning glory. but, size-primarily based reaction assessment did not constantly correlate with histopathological response. extensively, numerous patients categorised as solid disorder by using length criteria confirmed marked increases in ADC values and have been later confirmed to have completed pCR. This discordance underscores the superior sensitivity of DW-MRI in taking pictures microstructural adjustments within the tumor microenvironment before macroscopic changes grow to be evident (Table 5).

**Table no. 5: Comparison Between Tumor Size Reduction and ADC Changes**

| Response Parameter | Value |
|---|---|
| Mean Tumor Size Reduction (%) | $43.2\% \pm 9.7\%$ |
| Patients with ≥30% Size Reduction | 48 (58.5%) |
| Patients with ≥25% ΔADC1 | 53 (64.6%) |
| Patients with ≥30% Size Reduction but <25% ΔADC1 | 11 (13.4%) |
| Patients with <30% Size Reduction but ≥25% ΔADC1 | 16 (19.5%) |

The consistency and reliability of ADC measurements had been evaluated by way of comparing readings from experienced radiologists who independently analyzed the imaging facts. The intraclass correlation coefficient (ICC) for interobserver settlement ranged between 0.88 and 0.93, indicating superb reproducibility. In handiest 6% of instances had been discrepancies located, all of which have been resolved via consensus overview. A random subsample of 15 cases underwent repeat ADC dimension, which yielded a coefficient of variant (CV) of much less than 5%, further asserting the robustness of the size protocol.

a detailed subgroup evaluation was achieved to research the correlation among tumor molecular subtype and ADC kinetics. HER2-enriched tumors exhibited the maximum large early ADC growth (ΔADC1 = +35.4%), followed by triple-negative tumors (+28.7%). Luminal A and luminal B tumors confirmed extra modest will increase in ADC values (+15.3% and +20.1%, respectively). those tendencies corresponded with the pCR rates discovered throughout subtypes: HER2-enriched (48.4%), triple-terrible (38.4%), and luminal A (21.4%), suggesting that diffusion kinetics may also mirror the inherent chemosensitivity of different tumor biology (desk 6).

these findings spotlight the capacity of DW-MRI now not simplest in early reaction tracking but additionally in tailoring subtype-precise therapeutic strategies.

**Table 6: Subtype-wise ΔADC1 and pCR Rate**

| Molecular Subtype | Mean ΔADC1 (% change) | pCR Rate (%) |
|---|---|---|
| Luminal A | +15.3% ± 4.2% | 21.4% |
| Luminal B (HER2−) | +20.1% ± 5.1% | 29.0% |
| HER2-Enriched | +35.4% ± 6.7% | 48.4% |
| Triple Negative | +28.7% ± 5.8% | 38.4% |

## DISCUSSION

This potential longitudinal observe carried out at Katihar medical university evaluated the application of diffusion-weighted MRI (DW-MRI), specifically serial modifications in obvious diffusion coefficient (ADC) values, as an early predictor of neoadjuvant chemotherapy (NACT) response in patients with locally superior breast most cancers (LABC). The findings indicate that early increases in ADC values after the primary cycle of chemotherapy are extensively related to pathologic complete response (pCR) on the cease of treatment. The look at similarly validates DW-MRI as a touchy, reproducible, and non-invasive imaging modality capable of detecting microstructural alterations inside tumors nicely earlier than observable changes in tumor size, thereby providing an in advance insight into chemosensitivity.

The number one outcome of this examines, the statistically full-size upward thrust in ADC after the first NACT cycle in patients who subsequently carried out pCR, is in agreement with current literature [28]. preceding studies have constantly reported that effective chemotherapy outcomes in decreased tumor cellularity and membrane integrity, that's reflected via multiplied water diffusion and therefore higher ADC values [29]. furthermore, the excessive interobserver agreement in ADC measurements discovered in this look at supports its reliability in scientific exercise, echoing comparable reproducibility results seen in multicentric imaging validation studies [30]. The discovered sensitivity (eighty two.1%) and specificity (79.6%) for early ADC exchange thresholds in predicting pCR are akin to or exceed formerly posted diagnostic overall

performance metrics for DW-MRI in breast most cancers reaction assessment [31].

the translation of these findings holds several crucial implications. first of all, DW-MRI allows early discrimination among responders and non-responders inside the first cycle of NACT, allowing clinicians to don't forget therapeutic escalation or early surgical intervention in non-responders, thus minimizing useless toxicity. Secondly, the better ADC kinetics observed in HER2-enriched and triple-bad breast cancer (TNBC) subtypes offer an extra imaging biomarker to complement molecular profiling in treatment monitoring. these observations are clinically relevant as these subtypes are regarded for his or her competitive biology but also are much more likely to achieve pCR with systemic therapy [32]. DW-MRI therefore gives a mechanism to dynamically examine chemosensitivity beyond static receptor-based totally classification.

This observe also contributes new evidence in the Indian healthcare context, particularly from a semi-city placing. The evaluation-unfastened nature of DW-MRI gives realistic blessings in useful resource-constrained environments, in which assessment-more advantageous MRI won't be feasible due to cost constraints or renal insufficiency. The operational simplicity of ADC measurements and the feasibility of integration into recurring imaging workflows make DW-MRI a scalable era for early reaction evaluation in breast cancer [33]. moreover, as personalised oncology profits momentum, the ability to dynamically stratify sufferers based totally on early

remedy response may additionally form the premise of destiny adaptive treatment algorithms.

nonetheless, several barriers have to be acknowledged. This turned into a single-center study with a moderate pattern length, doubtlessly restricting generalizability. at the same time as ADC measurements had been standardized and reproducibility become high, inherent organic heterogeneity throughout tumors and intra-lesional variation may want to have stimulated regional ADC values. additionally, histopathological correlation trusted publish-remedy surgical specimens; as a result, real-time pathology affirmation during treatment changed into no longer possible. even as the look at used rigorous ROC-based totally evaluation to define most excellent ADC cutoffs, external validation in a multicenter cohort with longer observe-up statistics on recurrence and survival is warranted.

No major controversies were encountered, though ongoing debates continue to be regarding the use of multiparametric MRI (along with perfusion and spectroscopy) as opposed to DW-MRI on my own. whilst some authors argue for a multiparametric approach for greater accuracy [34], this observe reinforces the standalone cost of DW-MRI in early response prediction. Importantly, the findings also help the trend in the direction of purposeful imaging biomarkers over conventional size-based totally metrics, as meditated in recent breast imaging and oncology guidelines [35]. destiny studies have to purpose to refine the ADC thresholds across

molecular subtypes and combine machine mastering models for automated response prediction. huge-scale, multicentric potential trials incorporating clinical consequences which includes disease-loose

and general survival are vital to verify these findings and justify modifications in treatment planning paradigms.

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