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# ECCT Modulates the Therapeutic Landscape for Advanced Lung Adenocarcinoma: A Case Series Demonstrating Efficacy Across EGFR-Mutant and Wild-Type Subtypes

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## Abstract

**Background**: Lung cancer remains a leading cause of cancer-related mortality worldwide. Electro-Capacitive Cancer Therapy (ECCT), a non-invasive treatment utilizing alternating electric fields, has emerged as a promising adjunctive modality by selectively disrupting cancer cell mitosis. This study presents a case series evaluating the clinical outcomes of ECCT as an additive therapy for patients with advanced lung adenocarcinoma.

**Methods**: Six patients with stage IV pulmonary

adenocarcinoma (two EGFR wild-type, four EGFR-mutant) were treated with ECCT concurrently with standard therapeutic modalities, including chemotherapy, radiotherapy, immunotherapy, or tyrosine kinase inhibitors (TKIs). ECCT was administered at a frequency of 100–150 kHz and a voltage of 20–30 Vpp, typically for 30 minutes to 4 hours daily, five days a week. Treatment response was evaluated through serial imaging (CT and PET-CT).

**Results**: All six patients demonstrated sustained clinical benefit. Five patients achieved a partial response (PR), and one maintained stable disease (SD), with significant tumor regression observed across all cases. The treatment was exceptionally well-tolerated, with no severe adverse events reported. Clinical improvements were observed irrespective of the patients' EGFR mutation status.

**Conclusion**: This case series suggests that ECCT is a safe and effective adjunctive therapy for stage IV lung adenocarcinoma, significantly enhancing the efficacy of standard treatments across different molecular subtypes. These promising real-world results align with emerging evidence from larger trials and preclinical studies on electric field-based therapies. These findings warrant further investigation in larger, prospective clinical trials to establish ECCT's definitive role in precision oncology frameworks.

**Keywords**: Lung cancer; Case series; EGFR; ECCT; Adenocarcinoma

## Introduction

Lung cancer remains one of the most prevalent and lethal malignancies worldwide, ranking as the leading cause of cancer-related deaths [1-3]. Despite significant progress in diagnostic and therapeutic strategies, including targeted therapies and immunotherapies, the prognosis for advanced-stage lung cancer remains challenging, with 5-year survival rates below 10% [4,5]. Tumor recurrence, metastasis, and resistance to therapy continue to impede successful management. These challenges underscore the importance of targeting not only genetic alterations but also the metabolic and microenvironmental hallmarks of lung cancer [6–11]. Recent advances in cancer biology have

introduced Electrical Field (EF)-based therapies as promising non-invasive approaches. Electro-Capacitive Cancer Therapy (ECCT) utilizes alternating electric fields to disrupt mitotic spindle assembly by targeting microtubule dynamics during cell division, leading to apoptosis and inhibition of tumor growth [12]. In fact, this therapeutic modality, known as Tumor Treating Fields (TTFields), has been established as a standard of care for patients with glioblastoma, where it has been shown to significantly improve survival in a large-scale randomized clinical trial [13]. ECCT has demonstrated antiproliferative effects in various preclinical models, including glioblastoma and breast cancer, with findings suggesting modulation of immune responses and anti-proliferative signaling pathways [14,15]. Moreover, early clinical applications have shown tumor regression and improved patient outcomes [16]. Initial toxicological studies also suggest a favorable safety profile on vital organs [17]. Importantly, the electrical and metabolic vulnerabilities of the Tumor Microenvironment (TME) suggest that ECCT may provide a unique therapeutic advantage by selectively targeting cancer cell physiology while sparing normal tissues.

Given the molecular heterogeneity of lung cancer and the limitations of current treatment modalities, ECCT represents a potential paradigm shift in lung cancer therapy. Notably, the efficacy of this approach in advanced non-small cell lung cancer was recently demonstrated in the pivotal LUNAR phase 3 clinical trial, which reported a significant improvement in overall survival for patients receiving TTFields with standard therapies [18]. In light of these promising findings, this study aims to report our clinical experience on the outcomes of ECCT in patients with lung adenocarcinoma and to explore its potential integration into precision oncology strategies.

## Method

Study Design and Patient Cohort: This study was conducted as a case series involving six patients diagnosed with advanced pulmonary

adenocarcinoma. The patient characteristics are summarized in **Table 1**. The cohort included two males and four females, with ages ranging from 37 to 76 years. Two patients had EGFR wild-type tumors, while four had EGFR-positive mutations. All patients were classified as clinical stage IIIA to IVA.

**Table 1:** Patient Characteristics and Treatment Overview.

| Case No. | age | sex | Pathology TNM clinical stage | EGFR | Previous tx | Concurret tx | ORR |
|---|---|---|---|---|---|---|---|
| 1 | 44 | M | Adeno T4N1M0 IIIA | Wild type | none | Chemo + RT | PR |
| 2 | 52 | M | Adeno T4N2M1a IVA | Wild type | none | Chemo + ICI | PR |
| 3 | 37 | F | Adeno T4N2M0 IIIB | Positive | none | Gefitinib | SD |
| 4 | 76 | M | Adeno T3N1M0 IIIA | Positive | none | Osimertinib | PR |
| 5 | 54 | F | Adeno T3N2M1b IVA | Positive | none | Osimertinib | PR |
| 6 | 64 | F | Adeno T3N2M0 IIIB | Positive | none | Gefitinib | PR |

**Treatment Protocol**: All patients received ECCT as an adjunctive treatment to their primary standard-of-care therapy. The concurrent treatments included chemotherapy and radiotherapy (Case 1), chemotherapy and immunotherapy (Case 2), gefitinib (Cases 3 and 6), and osimertinib (Cases 4 and 5). ECCT was delivered using a non-invasive device, applying alternating electric fields at a frequency of 100–150 kHz and a peak-to-peak voltage of 20–30 Vpp. The treatment was typically administered for 30 minutes to 4 hours daily, five days per week.

**Assessment and Follow-up**: Tumor response was monitored using Computed Tomography (CT) and Positron Emission Tomography-Computed Tomography (PET-CT) scans at baseline and

regular intervals during the follow-up period. Radiologic changes in tumor size and metabolic activity (SUVmax) were documented to assess treatment efficacy. The clinical course and any adverse events were also monitored throughout the treatment period.

## Results

We report six cases of stage IV pulmonary adenocarcinoma treated with Electro-Capacitive Cancer Therapy (ECCT) in combination with standard modalities. Two patients had EGFR wild-type tumors, while four exhibited EGFR mutations. All patients received ECCT at a frequency of 100–150 kHz and voltage of 20–30 Vpp, typically administered five days per week for 30 minutes to 4 hours daily. Clinical outcomes and imaging findings are summarized below.

### Case 1: EGFR Wild-Type Adenocarcinoma with Chemotherapy and Radiotherapy

A 44-year-old male presented with a right lung mass (7.0 × 5.9 × 7.4 cm) confirmed as EGFR wild-type adenocarcinoma with PD-L1 TPS 80%. He underwent chemotherapy (6 cycles), radiotherapy (48 sessions), and ECCT before and after radiation. CT scans showed progressive tumor reduction: 5.8 × 5.6 × 1.8 cm at 6 months, 5.7 × 5.5 × 1.8 cm at 9 months, and 4.4 × 2.5 × 1.1 cm at 12 months **(Figure 1A–D)**. No new lesions were detected. The patient discontinued chemotherapy due to side effects and continued ECCT as maintenance.

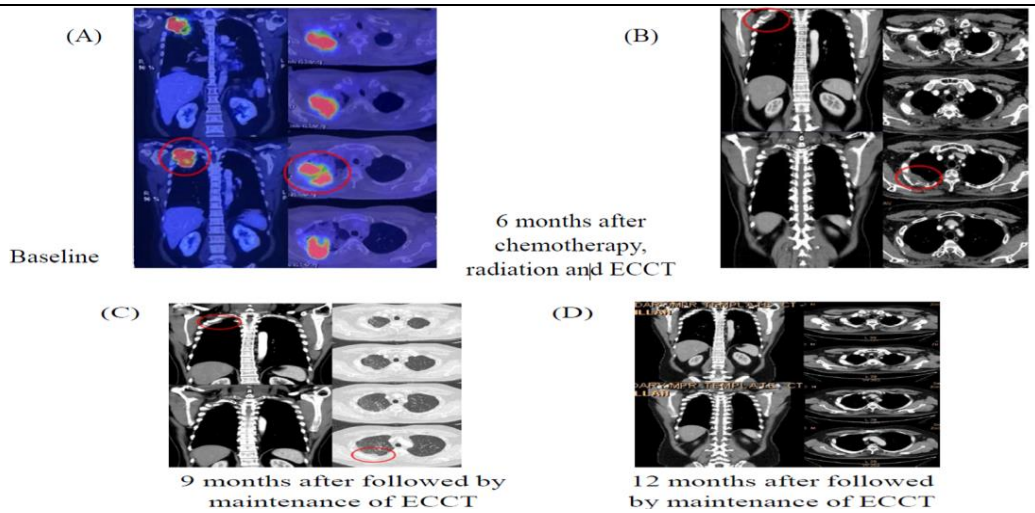
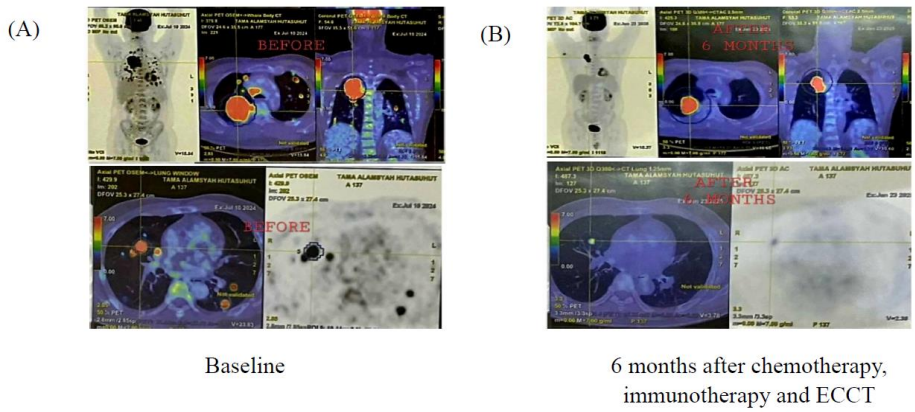



**Figure 1:** Case 1: Serial CT and PET-CT scans showing baseline tumor (A), reduction at 6 months (B), 9 months (C), and 12 months (D) post-treatment.

**Case 2: EGFR Wild-Type Adenocarcinoma with Chemotherapy and Immunotherapy**

A 52-year-old male with bilateral pulmonary masses was diagnosed with stage IV EGFR wild-type adenocarcinoma. He received chemotherapy (6 cycles), immunotherapy (discontinued at 3 months), and ECCT. PET-CT at 6 months showed tumor shrinkage from 6.0 × 5.8 × 7.5 cm (SUVmax 30.8) to 4.5 × 3.9 × 5.4 cm (SUVmax 14.2), with reduced nodules and metabolic activity **(Figure 2A–B)**. ECCT was well tolerated, with no severe adverse events.




Baseline

6 months after chemotherapy, immunotherapy and ECCT

**Figure 2:** Case 2: Baseline PET-CT (A) and 6-month follow-up (B) showing significant tumor regression.

**Case 3: EGFR-Mutant Adenocarcinoma with Gefitinib**

A 37-year-old female with EGFR-positive adenocarcinoma presented with dyspnea and chest pain. Initial CT showed a mass of 3.6 × 3.6 × 7.3 cm. Gefitinib and ECCT were initiated concurrently. At 4 months, CT showed partial regression (2.6 × 3.6 × 6.2 cm), and at 8 months, tumor volume had decreased by ~30% **(Figure 3A–C)**. The patient resumed normal activities with minimal symptoms.

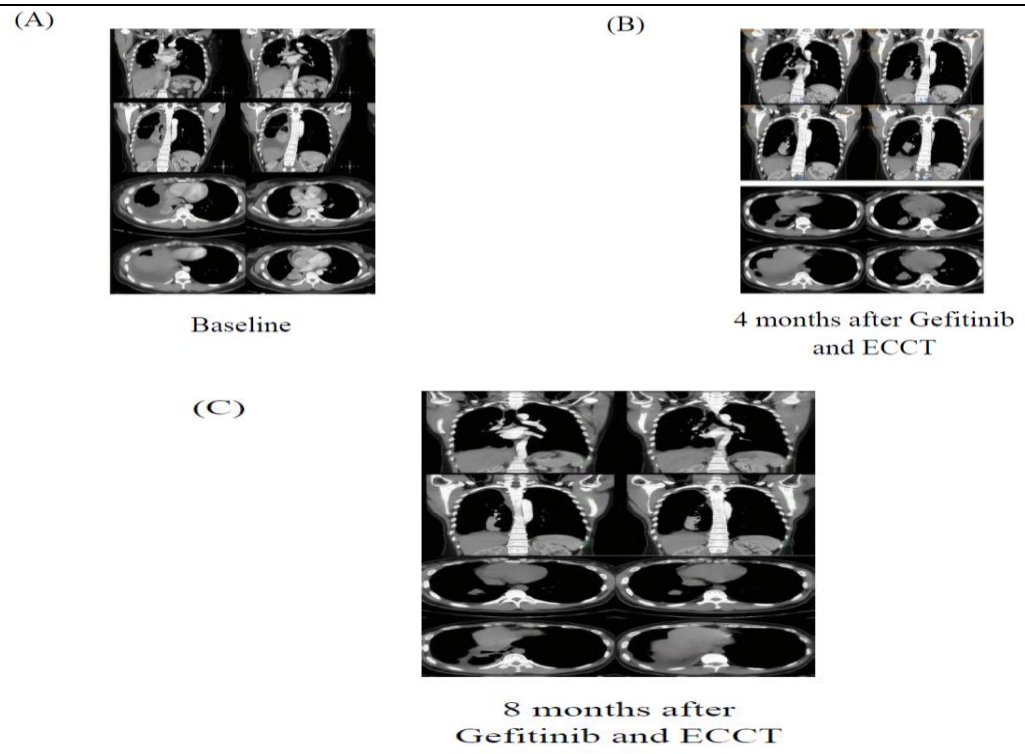



**Figure 3:** Case 3: Baseline CT (A), 4-month (B), and 8-month (C) scans showing progressive tumor reduction.

**Case 4: EGFR-Mutant Adenocarcinoma with Osimertinib**

A 76-year-old male with EGFR-positive adenocarcinoma received Osimertinib and ECCT. Initial CT showed a mass of 4.3 × 6.8 × 4.0 cm. Tumor size reduced to 1.3 × 2.0 × 1.5 cm at 3 months and 0.8 × 0.7 × 0.7 cm at 5 months **(Figure 4A–C)**. The patient maintained stable clinical status and resumed light physical activity.

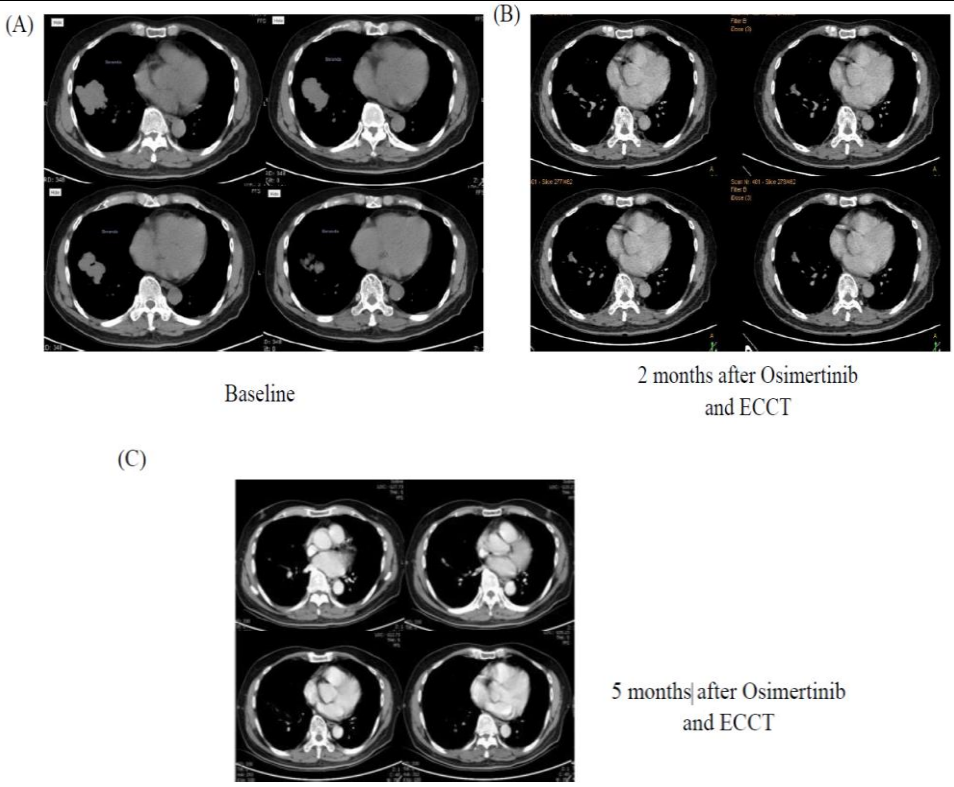



**Figure 4:** Case 4: Baseline CT (A), 2-month (B), and 5-month (C) scans showing tumor regression.

**Case 5: EGFR-Mutant Adenocarcinoma with Osimertinib and Metastases**

A 54-year-old female with EGFR-positive adenocarcinoma presented with pulmonary nodules, bone metastases, and brain lesions. She received Osimertinib and ECCT. At 5 months, PET-CT showed tumor shrinkage and resolution of bone metastases. At 9 months, lung lesions were significantly reduced **(Figure 5A–C)**. The patient regained mobility and daily function.

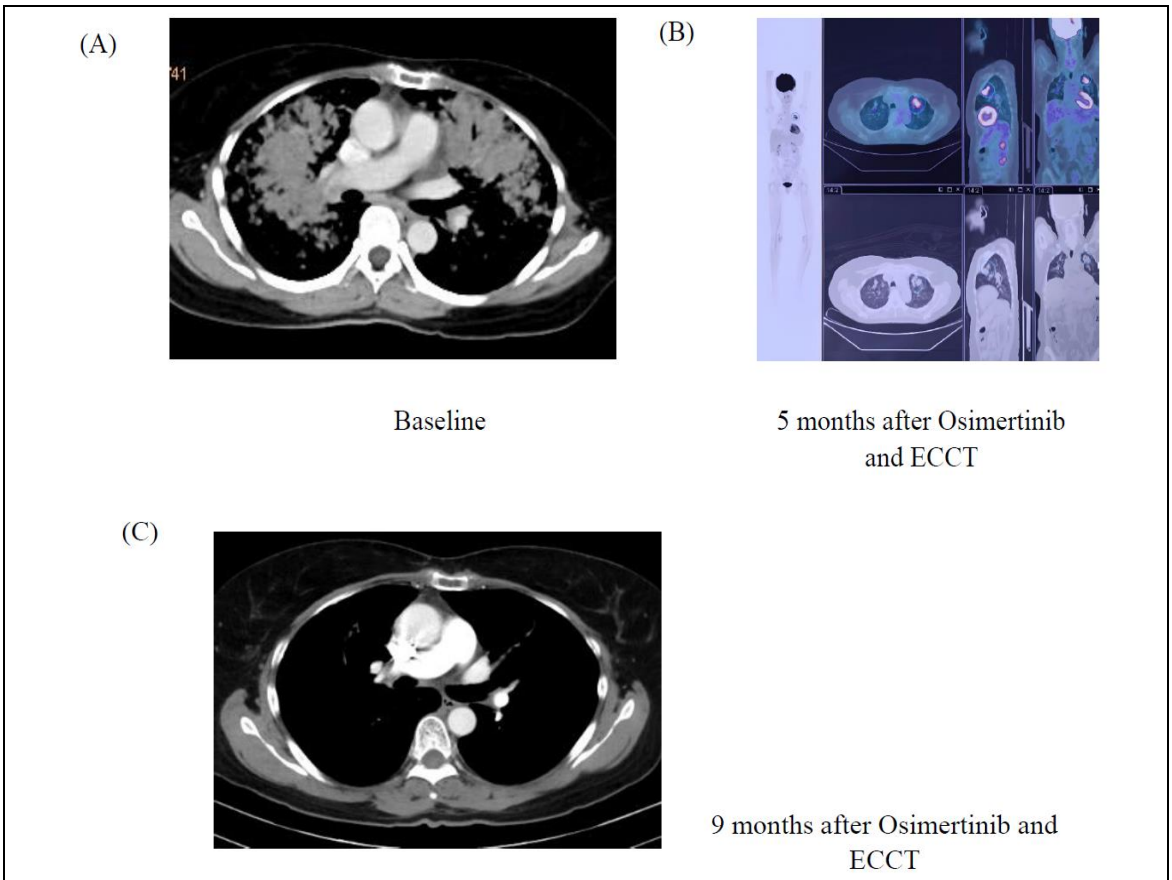



**Figure 5:** Case 5: Baseline CT (A), 5-month (B), and 9-month (C) scans showing systemic response.

**Case 6: EGFR-Mutant Adenocarcinoma with Gefitinib**

A 64-year-old female with EGFR-positive adenocarcinoma received Gefitinib and ECCT. Initial CT showed a mass of 5.2 × 4.8 cm. After one year, dyspnea resolved. Treatment was interrupted during the COVID-19 pandemic. Upon resumption, CT in 2025 showed tumor reduction compared to 2023 **(Figure 6A–C)**. The patient remained asymptomatic.

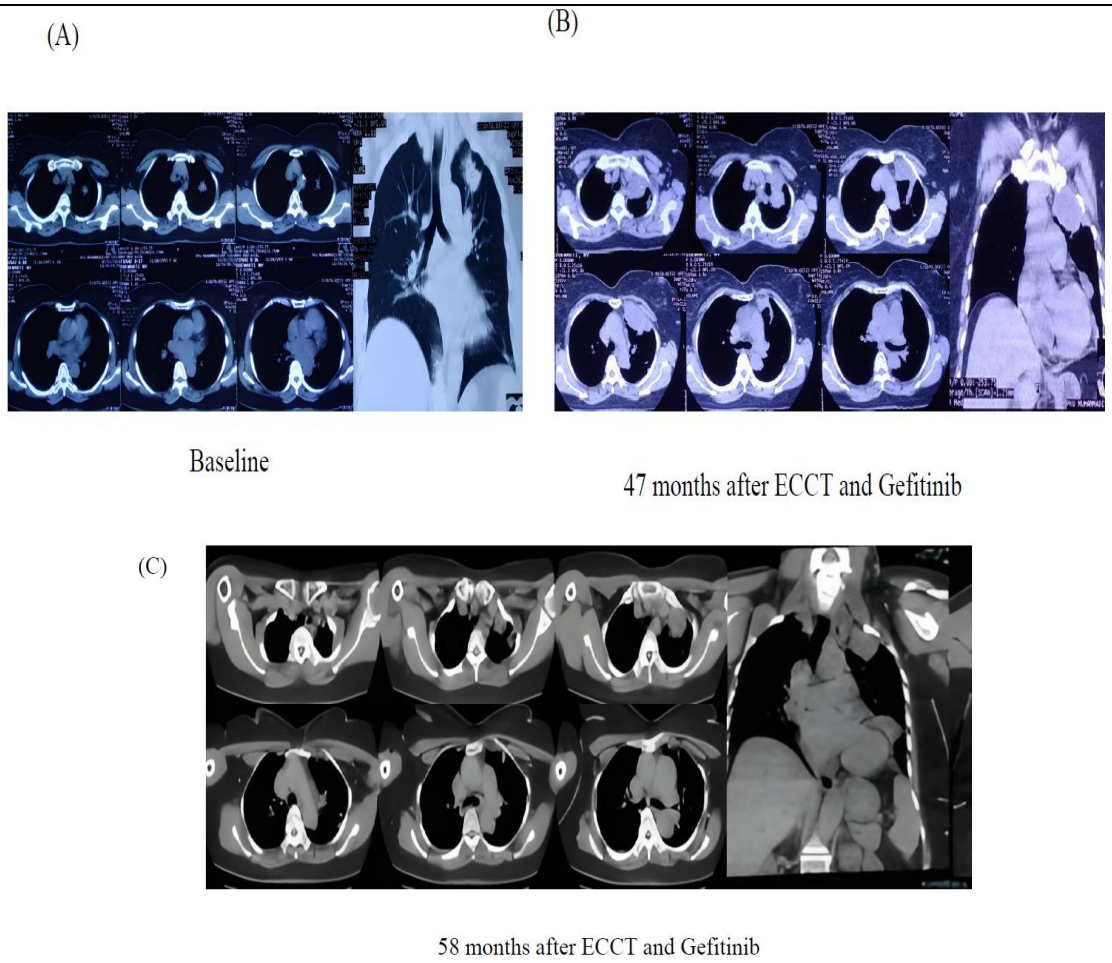



**Figure 6:** Case 6: Baseline CT (A), 47-month (B), and 58-month (C) scans showing long-term disease control.

## Integration with Discussion

These results demonstrate consistent partial responses across diverse EGFR mutation statuses and treatment combinations. Notably, ECCT was well tolerated and contributed to tumor regression in both EGFR wild-type and EGFR-mutant cases. The imaging data support the hypothesis that ECCT may enhance the efficacy of conventional and targeted therapies by exploiting the electrical and metabolic vulnerabilities of the tumor microenvironment. The observed outcomes align with prior preclinical findings on ECCT's antiproliferative effects, and suggest its potential utility in precision oncology, particularly for patients with limited options or intolerance to systemic therapies.

## Discussion

Our case series suggests that ECCT provides notable clinical benefit across various treatment combinations. Particularly, Case 2, who received ECCT concurrently with an Immune Checkpoint Inhibitor (ICI), achieved a deep and sustained partial remission. This outcome aligns with emerging evidence regarding the synergistic interaction between electric field therapies and modern immunotherapy. Specifically, recent literature indicates that the application of Tumor Treating Fields (TTFields) can enhance the immune response by promoting Immunogenic Cell Death (ICD) and subsequently increasing the presentation of tumor antigens [19]. Furthermore, this physical stress may modulate the tumor microenvironment and increase T-cell infiltration, thus potentially overcoming resistance to ICI. Therefore, the exceptional response observed in Case 2 may be a direct result of this potent synergy, where ECCT acts not only as a cytostatic agent but also as an *in situ* tumor vaccine, maximizing the efficacy of the accompanying ICI treatment. Conversely, our patient cohort also included four patients (Cases 3–6) receiving ECCT concurrently with Epidermal Growth Factor Receptor-Tyrosine Kinase Inhibitors (EGFR-TKIs), such as gefitinib and osimertinib. All four patients demonstrated sustained clinical benefit without significant additive toxicity, suggesting a feasible and effective combination regimen. The potential synergy between TTFields and targeted therapies, particularly in NSCLC, has been highlighted in recent academic reviews. KÖHLER M, et al. specifically reviewed the rationale for combining TTFields with EGFR-TKIs and other targeted agents [20]. They propose that TTFields may sensitize cancer cells to these molecular drugs by disrupting the cell cycle and altering membrane permeability, thereby enhancing drug uptake. Our observation of prolonged stability and response in patients with EGFR-mutated disease strongly aligns with the mechanistic hypothesis described in this narrative review. This suggests that ECCT may serve as a critical component in overcoming or delaying resistance mechanisms often

associated with TKI monotherapy.

In patients with EGFR-mutated disease (Cases 3–6), the concurrent application of ECCT with TKIs resulted in progressive radiologic improvement and enhanced quality of life. This sustained response strongly suggests that ECCT may potentiate the therapeutic effects of targeted agents. This synergy is likely rooted in ECCT's ability to exploit the unique vulnerabilities of the Tumor Microenvironment (TME). Specifically, the electrically distinct nature of the lung cancer TME—characterized by acidic conditions, EMT, and altered ion transport—may render cancer cells particularly susceptible to electric field-based interventions. ECCT's ability to selectively target proliferative cells while sparing normal tissues aligns with this mechanistic rationale. Nonetheless, several limitations must be acknowledged. First, the absence of a control group precludes definitive conclusions regarding ECCT's independent efficacy. Second, imaging-based assessments were not uniformly standardized, and metabolic activity was not consistently quantified across all cases. Third, the compassionate use setting introduces potential selection bias, as patients opting for ECCT may differ in clinical motivation or disease trajectory. Future studies should aim to validate these findings in larger, controlled cohorts with standardized imaging protocols and biomarker analyses. Integration of ECCT into precision oncology frameworks—potentially guided by TME profiling or electrical impedance mapping—may further refine patient selection and optimize therapeutic outcomes.

## Conclusion

This case series demonstrates that Electro-Capacitive Cancer Therapy (ECCT) is a promising and well-tolerated adjunctive modality in the management of stage IV pulmonary adenocarcinoma. The consistent clinical benefit observed across both EGFR wild-type and EGFR-mutant subtypes, characterized by measurable tumor regression and improved quality of life, supports the mechanistic rationale that ECCT enhances the efficacy of both conventional and targeted therapies. These real-world findings align

with emerging evidence from larger trials and preclinical studies on electric field-based therapies. Given its favorable safety profile and synergistic potential, ECCT warrants rigorous, prospective clinical investigation to firmly establish its optimal role within precision oncology frameworks.

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