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Short Communication

The Roles of miRNA in Lung Cancer among Women

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Lung cancer remains one of the leading causes of cancer-related mortality worldwide, with significant gender-specific differences in its incidence, etiology, and outcomes. Among women, lung cancer poses a unique challenge due to differences in hormonal influence, genetic predispositions, and exposure to risk factors such as smoking and environmental carcinogens. In recent years, microRNAs (miRNAs) have emerged as critical regulators of gene expression and promising biomarkers in cancer diagnosis, prognosis, and treatment response. This review explores the roles of miRNA biomarkers in lung cancer, focusing on their implications for women.

miRNAs: An overview

MicroRNAs are small, non-coding RNA molecules that regulate gene expression post-transcriptionally by binding to complementary sequences on target messenger RNAs (mRNAs) [1]. This binding leads to mRNA degradation or translational inhibition, thereby influencing various cellular processes such as proliferation, apoptosis, and differentiation. In cancer, dysregulated miRNA expression contributes to tumorigenesis, metastasis, and resistance to therapy [2].

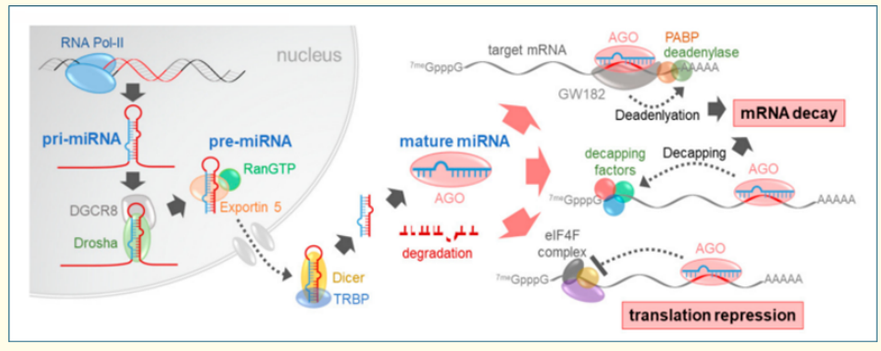

Figure 1: Biogenesis and functional mechanisms of miRNAs [3].

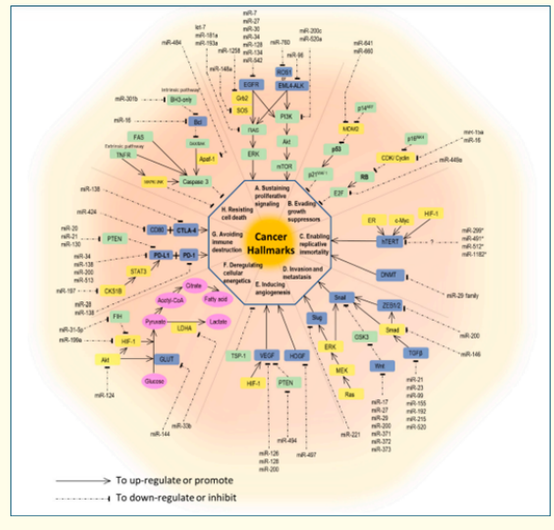

Figure 2: A diagram of microRNAs and their involved pathways to cancer hallmarks [4].

Gender-specific roles of miRNAs in lung cancer

Research indicates that women with lung cancer exhibit distinct miRNA expression profiles compared to men, which may be attributed to hormonal differences, especially the influence of estrogen [5]. Estrogen receptors (ERα and ERβ) are expressed in lung tissues and can modulate miRNA expression, affecting cancer progression [6].

Key miRNAs implicated in lung cancer among women

- miR-21: Known as an "oncomiR," miR-21 is overexpressed in lung cancer and promotes tumor growth, invasion, and resistance to apoptosis. Studies suggest that its expression is higher in women, possibly due to estrogen receptor-mediated regulation [5].
- miR-34a: A tumor-suppressive miRNA, miR-34a is often downregulated in lung cancer. It plays a role in inhibiting cell cycle progression and inducing apoptosis. Restoration of miR-34a levels has shown potential in sensitizing tumors to chemotherapy [2].
- miR-155: Frequently overexpressed in non-small cell lung cancer (NSCLC), miR-155 is associated with poor prognosis and increased metastatic potential. It has been linked to immune system modulation, a critical factor in the tumor microenvironment [6].
- Let-7 family: As tumor suppressors, Let-7 miRNAs regulate oncogene expression and are often downregulated in lung cancer. Their loss is correlated with poor outcomes, particularly in women with adenocarcinoma [7].

Diagnostic and prognostic potential

- The unique expression patterns of miRNAs in women with lung cancer highlight their utility as non-invasive biomarkers. miRNAs can be detected in body fluids such as blood, sputum, and urine, making them suitable for early detection and monitoring [5].
- Early Detection: Panels of miRNAs, including miR-21, miR-210, and Let-7, have demonstrated high sensitivity and specificity in distinguishing lung cancer patients from healthy individuals [7].
- Prognostic Indicators: Dysregulated miRNAs such as miR-21 and miR-155 are associated with poor survival rates, whereas higher levels of Let-7 family members indicate better prognosis [2].
- Therapeutic Monitoring: Changes in circulating miRNA levels can reflect treatment response, aiding in personalized therapy [8].

Therapeutic applications

Targeting miRNAs offers a novel approach for lung cancer treatment [9]. Strategies include:

- miRNA Mimics: Synthetic miRNA mimics can restore the function of tumor-suppressive miRNAs such as Let-7 and miR-34a [2].
- miRNA Inhibitors: Anti-miR molecules can suppress oncomiRs like miR-21 and miR-155, reducing tumor growth and metastasis [6].
- Combination Therapies: Integrating miRNA-based therapies with traditional treatments such as chemotherapy and immunotherapy may enhance efficacy and overcome resistance [8].

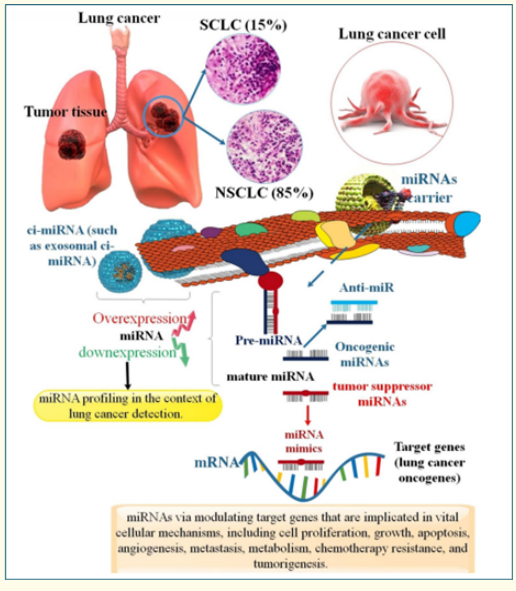

Figure 3: The function of microRNAs in lung cancer [9].

Challenges and future directions

While miRNAs show immense promise, several challenges remain:

- Standardization: Variability in miRNA detection methods and lack of standardized protocols hinder clinical translation [1].
- Specificity: Many miRNAs target multiple genes, leading to off-target effects and potential toxicity [2].
- Gender-Specific Research: More studies focusing on women needed to elucidate the interplay between hormonal factors and miRNA regulation in lung cancer [5].

Future research should aim to develop robust miRNA-based diagnostic tools and therapeutic agents, with a particular emphasis on personalized medicine for women [10-13].

Conclusion

miRNA biomarkers hold great potential in transforming the landscape of lung cancer management among women. By enabling early detection, providing prognostic insights, and offering novel therapeutic targets, miRNAs pave the way for improved outcomes in this high-risk group. However, addressing the existing challenges through rigorous research and technological advancements is essential for their successful integration into clinical practice.

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