



P1.054: Size-Amplified Fluorescent Gel Microspheres with Long-Lasting Signal for CTC Detection in Lung Adenocarcinoma

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INTRODUCTION

Detection of circulating tumor cells (CTCs) is a critical approach for assessing lung adenocarcinoma risk, widely used in early screening and post-treatment monitoring.^[1] Current CTC detection technologies combining size-based enrichment with fluorescent antibody labeling face two major limitations: loss of small-sized CTCs resulting in low capture efficiency, and weak fluorescence signal with short duration causing identification difficulties.^[2] This study proposes a fluorescent targeted gel microsphere that amplifies CTC system dimensions through its micron-scale size and enhances signal intensity and duration via high-loading fluorescence labeling, aiming to improve CTC capture efficiency and reduce identification difficulty.

METHODS

Sodium alginate microspheres (SAM) were prepared using an emulsion method. Targeting microspheres (SAM-anti-MUC1) were obtained by chemically conjugating anti-MUC1 antibody onto the SAM surface. Fluorescent targeted microspheres (SAM-anti-MUC1/RhB) were further constructed by loading Rhodamine B (RhB) via a swelling method. Using A549 lung adenocarcinoma cells as CTC mimics, binding experiments were performed with SAM, SAM-anti-MUC1, SAM-anti-MUC1/RhB, and tetramethylrhodamine isothiocyanate (TRITC) conjugated anti-MUC1 antibody (anti-MUC1-TRITC). SAM-anti-MUC1/RhB served as the experimental group, with the others as controls. System dimensions, along with fluorescence signal intensity and duration, were characterized using microscopy and flow cytometry.

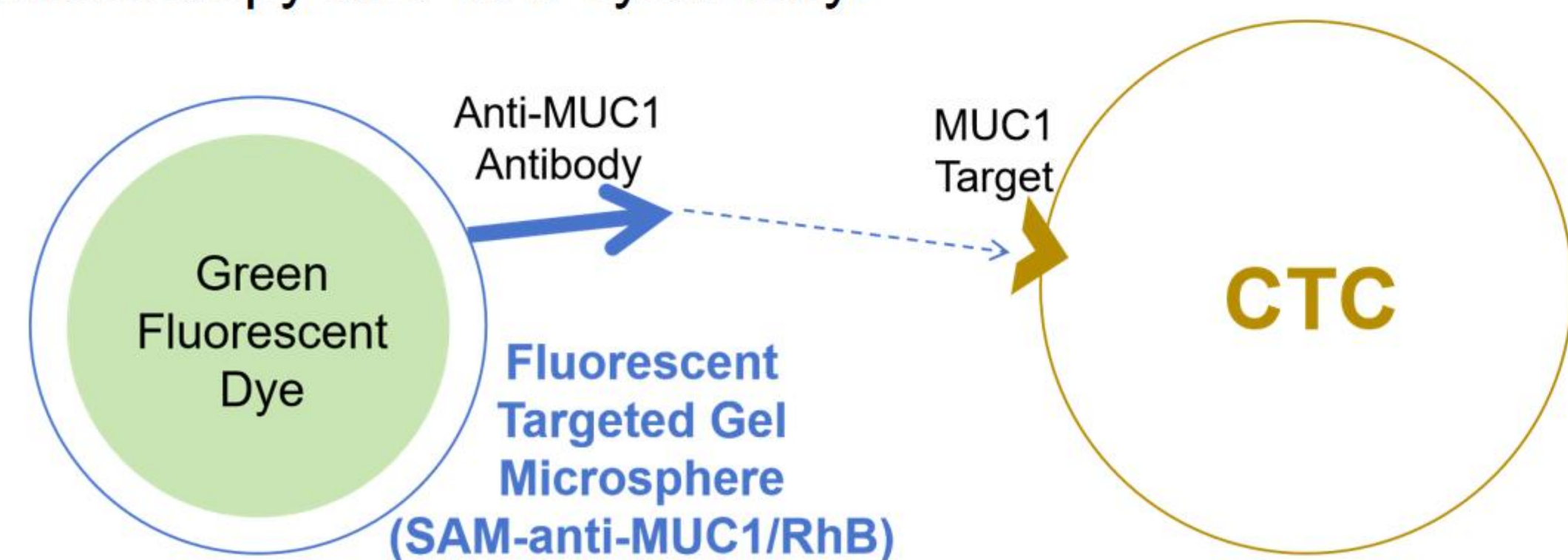


Figure 1: Working principle of fluorescent targeted gel microspheres in CTC detection.

DISCUSSION AND CONCLUSION

A MUC1-targeted fluorescent gel microsphere, SAM-anti-MUC1/RhB, was successfully constructed. This microsphere specifically recognizes A549 cells (CTCs mimics) via surface antibodies, simultaneously amplifies cellular system dimensions, and generates strong and persistent fluorescence signals through high-loading dye incorporation. This provides a novel technical strategy for improving CTCs capture efficiency and reducing fluorescence identification difficulty.

REFERENCES & ACKNOWLEDGEMENTS

References

1. Duffy et al., Nat Rev Clin Oncol 23:201-212 (2026).
2. Dai et al., Cancer Cell 43(8):1399-1422.

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RESULTS

Physical and chemical characterization confirmed successful preparation of SAM, SAM-anti-MUC1, and SAM-anti-MUC1/RhB microspheres. No significant specific binding was observed between SAM and A549 cells, whereas the other three reagents all specifically bound to A549 cells. Size characterization revealed that A549 cell binding to anti-MUC1-TRITC did not significantly alter system dimensions, whereas binding to SAM-anti-MUC1 or SAM-anti-MUC1/RhB significantly increased system dimensions. Fluorescence characterization demonstrated that the SAM-anti-MUC1/RhB group exhibited significantly higher fluorescence intensity and longer signal duration compared to the anti-MUC1-TRITC group.

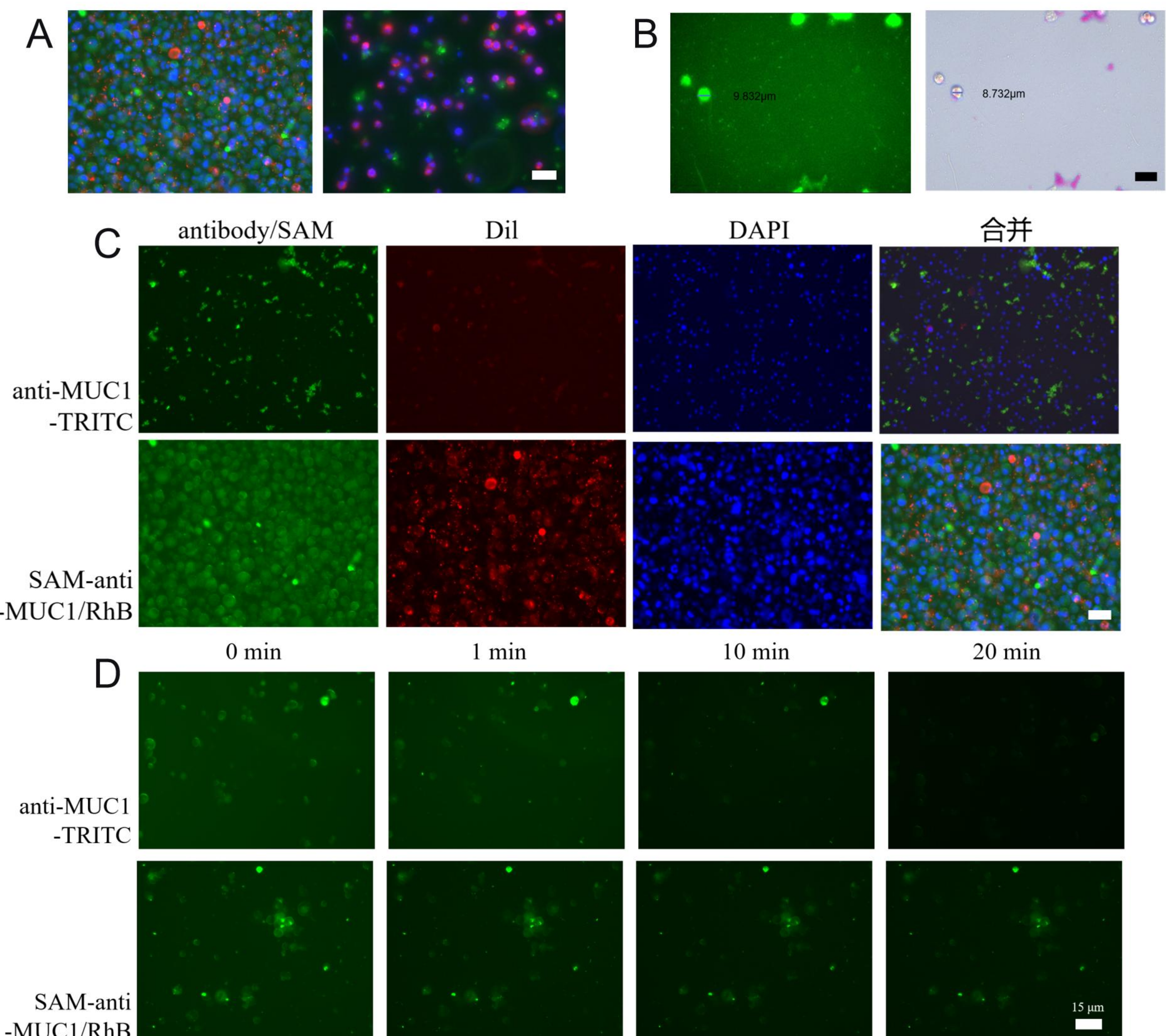


Figure 2: Targeting, capture efficiency, and fluorescence properties. (A) Preferential binding of SAM-anti-MUC1/RhB to A549 (left) vs. RAW264.7 (right). (B) A549 cell size enlargement after SAM-anti-MUC1/RhB labeling. (C) Fluorescence image of filtrate from mixed A549/RAW264.7 sample after 10-μm cell strainer filtration. (D) Fluorescence properties of anti-MUC1-TRITC and SAM-anti-MUC1/RhB under continuous excitation.