

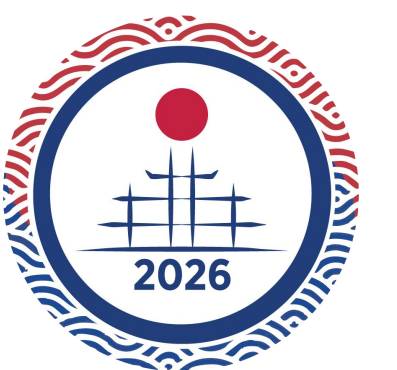


P1.062: Peripheral Blood Immune Phenotyping Identifies Three Distinct Clusters in Pulmonary Nodule Patients

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INTRODUCTION

Pulmonary nodules are increasingly detected with widespread CT screening, yet risk stratification remains challenging. Peripheral blood immune profiling may reveal systemic immune signatures associated with nodule biology and malignant potential. This study applied unsupervised clustering to peripheral blood immune cell subsets to identify immune phenotypes in pulmonary nodule patients and evaluate their clinical, radiological, and pathological correlates.

METHODS

A total of 148 subjects were enrolled, comprising 30 healthy controls, 51 patients with pulmonary nodules (35 pure GGO, 10 part-solid GGO, and 6 solid nodules), and 67 surgically resected patients with pathologically confirmed minimally invasive adenocarcinoma (MIA) or invasive adenocarcinoma. Flow cytometry quantified 12 immune cell subsets, including NK cells, T cells, B cells, and dendritic cells. K-means clustering was applied to immune cell profiles to identify distinct immune phenotypes, and UMAP dimensionality reduction was used for visualization. Associations between immune clusters and clinical, radiological, and pathological features were analyzed.

DISCUSSION AND CONCLUSION

Key Findings

- Unsupervised clustering identified three immune phenotypes with distinct clinical, radiological, and pathological correlates.
- The immunosuppressive phenotype was enriched in surgically confirmed invasive adenocarcinoma with part-solid GGO and solid nodules, suggesting higher malignant potential.
- The B-cell enriched phenotype, dominated by pure GGO, reflects acute immune activation without durable memory formation.

Future Direction for Research

- Peripheral blood immune phenotyping may serve as a non-invasive tool for risk stratification and personalized management of pulmonary nodule patients.

REFERENCES & ACKNOWLEDGEMENTS

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Artificial Intelligence (AI) Use Disclaimer

Artificial intelligence (AI) tools were only utilized for linguistic polishing and expression optimization during the manuscript writing of this study. All research design, data analysis, result interpretation and academic viewpoints were independently completed by the authors, with no AI participation in study conception, data processing and conclusion formulation.

RESULTS

Three immune phenotypes were identified:

Cluster 1 — B-cell Enriched (n=36, 24.3%):

- No healthy controls were present. Pure GGO predominated (63.9%), 77.8% were IAC.
- This phenotype was characterized by markedly elevated total B cells (41.15%), extremely high transitional B cells (84.68%), and very low memory B cells (4.32%), suggesting acute immune activation without memory formation.

Cluster 2 — Immunosuppressive (n=55, 37.2%):

- Surgical patients predominated (65.5%). Pure GGO was most common (50.9%), followed by part-solid GGO (29.1%). 73.0% were IAC.
- This phenotype exhibited impaired NK cell function (NKG2D⁺ 3.08%, CD56^{dim} CD16⁺ 8.96%), lowest total B cells (9.50%), and elevated Treg cells (9.49%), indicating tumor immune escape.

Cluster 3 — Immune Competent (n=57, 38.5%):

- Healthy controls were concentrated here (49.1%).
- This phenotype showed the highest CD8⁺ T cells (43.64%), robust NK function (NKG2D⁺ 20.27%, CD56^{dim} CD16⁺ 26.14%), mature memory B cells (13.91%), and high dendritic cells (43.09%), demonstrating strong anti-tumor immunity.

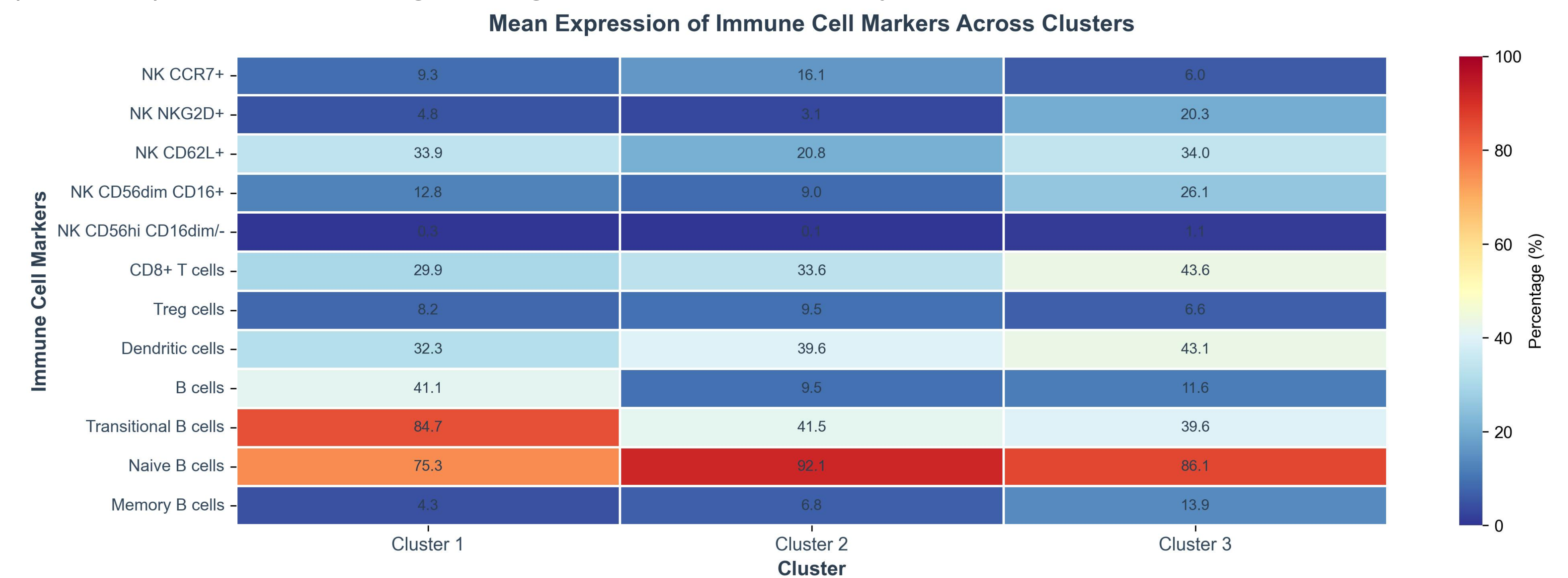


Figure 1: Heatmap of mean expression levels of 12 immune cell markers across three K-means clusters.

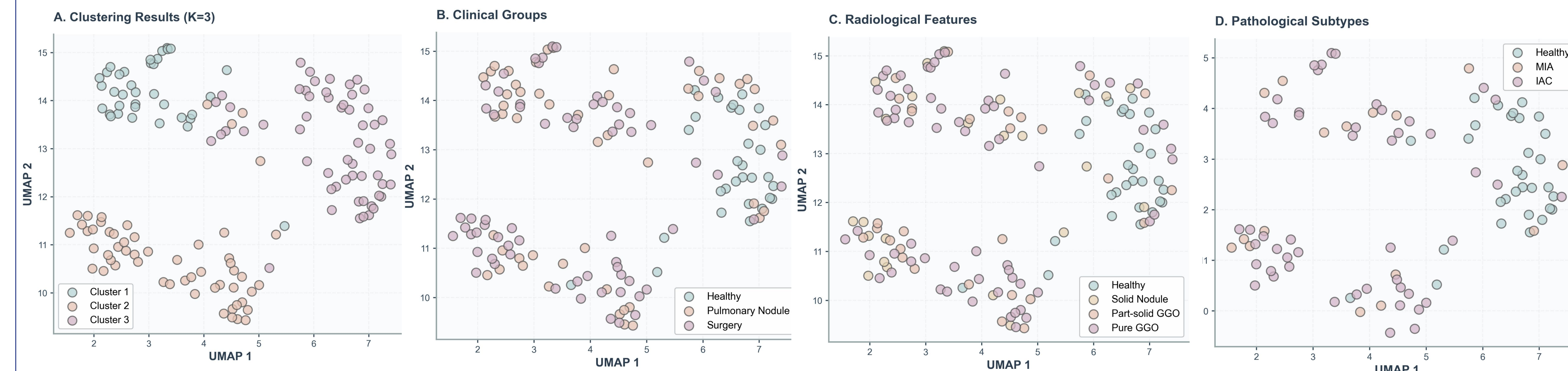


Figure 2: UMAP projections colored by clustering results (k=3), clinical groups, radiological features, and pathological subtypes.